A MNEMONIC TECHNIQUE FOR LEARNING
DISABLED CHILDREN

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Bachelor of Arts

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Kalamazoo, Michigan

1974

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
July, 1978

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ACKNOWLEDGEMENTS

The guidance throughout the course of this study of the members of my committee has been extremely helpful. I particularly want to express the deep respect that I have for my thesis adviser, Dr. Robert J. Weber. His wisdom, support, and encouragement have been invaluable in helping me struggle with both the study and my feelings concerning it. I want to thank the other members of my committee, Dr. H. Stephen Caldwell, Dr. Robert S. Schlottmann, and Dr. Phillip J. Murphy, for their suggestions concerning the study design, the data analysis, and the writing of this manuscript. Special thanks is given to Debbie and Phil Murphy for their aid in arranging for the subjects and providing the test information. I would also like to thank Dr. James Price for helping with the data analysis.

In addition, I would like to thank my parents, Mr. and Mrs. Warren Taylor, for their understanding and encouragement of my academic pursuits.

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CHAPTER I

INTRODUCTION

Deficits in the learning disabled child's ability to retain, recognize, recall, associate, and sequence what he has experienced are often mentioned by parents, teachers, and writers in the field (Cruickshank, 1967; Cruickshank & Hallahan, 1975; Johnson & Myklebust, 1967; Lerner, 1976; Myklebust, 1971). Memory difficulties often have a pervasive impact on a child's life. In school, a child with memory difficulties is likely to have more trouble in such basic skills as learning to read, do arithmetic and spell. He may also find it hard to retrieve what he has learned when he needs it and to even remember the teacher's instructions and assignments. The frustrations for the learning disabled child with memory difficulties are not limited to academic areas. They also influence remembering such aspects as activities, where he placed items, who people are, and even jokes to tell one's friends. Any deficit that severly impedes a child's functioning and progress in social, academic, and general living situations is likely to lead to great amounts of frustration. Frustration and failure frequently form a vicious cycle for many learning disabled youngsters (Cruickshank & Hallahan, 1975; Myklebust, 1971). The child finds he does not do as well at tasks as he and significant others in his life would like. At first he is likely to try harder. However, if his increased efforts do not bring improvement he may soon develop strong feelings of frustration and become convinced that he is stupid or that something is wrong with him. When expected to perform, he is likely to become anxious and tense and thereby remember things even less well. The next step may be avoidance of the areas where he has a great deal of frustration, a lack of self-confidence, and an unwillingness to approach new unknown tasks.

It certainly seems important that every effort be made to precisely identify particular memory deficits that a learning disabled child has and to teach the child ways to try to compensate. This may help prevent or interrupt a frustration-failure cycle for the child and possible emotional overlays to the learning difficulty. In order to identify memory deficits precisely and to devise effective compensatory methods, thorough research in the area is clearly needed. This document will bring together and analyze the research that has been done on the memory abilities of the learning disabled child. Based on the trends that appear there, a technique for possibly helping learning disabled children compensate for their memory deficits will be devised and investigated.

Review of the Literature

The research that will be discussed covers three areas: memory abilities in learning disabled children, mnemonic strategies, and the keyword method--a particular mnemonic technique that has been developed for learning foreign language vocabulary.

Memory Abilities in Learning Disabled Children

This is a review of experimental studies concerned with the memory abilities of children diagnosed as learning disabled, dyslexic, or reading disabled. A framework of information processing views is utilized in describing and interpreting the various works. That is, the literature will be analyzed in terms of various aspects of mnemonic processing: a modality-specific sensory memory stage, attention as it has a role in the processing of information between the sensory registers and a short-term store, primary memory, and finally the characteristics and processes of secondary memory (long-term storage). Results from the literature will be analyzed in terms of what they suggest about the integrity or impairment in each of these stages, the transfer of information from one stage to the following one, and the registration and retrieval processes involved in each stage.

Sensory Memory

Sensory memory refers to the holding in memory of relatively "raw" copies of the impinging patterns for a brief time after the stimulus is turned off. The two main forms of sensory memory that have been investigated with normal adults are visual sensory memory (iconic) and auditory sensory memory (echoic). A primary characteristic of such sensory traces is their very rapid forgetting rate--from one-third second to one second for iconic storage (Haber, 1970; Neisser, 1967) and about two seconds for echoic memory (Crowder & Morton, 1969; Neisser, 1967). Very little work has been reported that involves the comparison of sensory memory abilities for normal and learning disabled youngsters. Three studies concerning iconic memory will be presented. Studies on echoic memory with this population do not seem to have been done.

Morrison and Giordani (1977) presented letters, geometric forms, and abstract forms for 150 milliseconds (msec.) to twelve year old boys who were reading at a normal level and an experimental group who were two years behind in their reading level. Following the offset of the array of eight stimuli, a teardrop indicator appeared under one of the forms after an interval of: 0, 50, 100, 200, or 300 milliseconds. The subjects had to report which of the eight forms (presented now on a card) had been indicated. No differences were found between the two groups for any of the types of materials.

Stanley and Hall (1973) compared two measures of visual information processing for a dyslexic and a control group of eight to twelve year olds. The first measure involved presenting a part of a figure for 20 msec., followed by a varying interstimulus blank interval, and then presenting the rest of the figure for 20 msec. Increments of the interval were increased by 20 msec. steps. It took the dyslexics significantly longer than the control subjects to be able to see the two images as separate (not a composite). The memory time for such was under 370 msec. for both groups and all items. The second measure consisted of presenting a letter (made of dots) for 20 msec., a varying interval, and presenting a mask of a rectangular array of dots for 20 msec. The interstimulus interval was increased at 20 msec. intervals. To identify the letter took the dyslexics significantly longer than for the control subjects. The memory times were all under 150 msec. The authors concluded that significant differences exist between dyslexcis and normals at early stages of visual information processing. They suggested that the first task involved some memory scan process and the transfer of information from visual information storage to short-term memory. They implied that the scan and retrieval processes take a longer time for dyslexics.

Stanley (1975) used eight through twelve year old dyslexic and normal children as subjects. The procedure was similar to the first measure used by Stanley and Hall (1973). This time he used a tachistoscope and presented each part for five milliseconds. The intervals started at zero seconds and increased at one and five msec. intervals. Both dichoptic and binocular presentations were used. Here again the dyslexics needed a significantly longer interstimulus blank interval time to separate the forms.

The limited evidence presented suggests that iconic memory persists equally long for normals and retarded readers. Stanley and Hall's work suggest that difficulties may occur not in iconic memory but in getting information out of iconic and into primary memory.

Dichotic Listening Studies: Processing Information From Sensory Memory

For information that is in sensory memory to be retained, it must be rapidly further processed. One way such has been studied is with Broadbent's (1958) dichotic listening tasks. These involve the simultaneous presentation of two short series of digits, letters, or words, one series to each ear. Subjects typically recall all the available items presented to one ear before recalling the other series. Such research provides information both about (a) the processing of what is contained in sensory memory and (b) what happens to the second series that has to remain in sensory memory for a longer time period. A variety of information about both of these processes has come from studies with poor readers that utilize tasks similar to Broadbent's.

Senf (1969) tried to assess memory and attention differences between samples of male eight to fifteen year old retarded and adequate readers. He used an audiovisual analogue of Broadbent's dichotic listening task.

That is, subjects were asked to recall six discrepant digits that were presented as three pairs of simultaneous items. Of each pair, one digit was presented visually and one auditorily. All subjects preferred recalling the items in modality sets. Retarded readers preferred the auditory modality, while normals showed no modality preference. Retarded readers were generally as capable at recalling items but misordered them more frequently. Improvements with age were limited to the recall of visual stimuli. When items were color-object pairs so that redundancy between items could be manipulated, all the subjects used the redundancies to reduce errors.

Senf found that over the entire samples, normal readers were significantly better at recalling items by pairs when instructed to do so. This discrepancy between the groups increased sharply with age. Senf suggests that the pairing difficulty cannot be explained in terms of insufficient time to switch attention from one stimulus modality to the other. This is based on the observation that the poor readers had even more difficulty with the pair recall for a long inter-pair interval (two seconds) than a short interval (one-half second). He implies that memory or some other organization capacity must be responsible for the pairing deficit.

When the subjects were broken down into three age groups, the pattern of results was different. The groups were: a young group (mean age = 9.5 years), a medium group (mean age = 12.2 years), and an old group (mean age = 14.6 years). With young subjects, the normal and poor readers differed on modality recall but not on pair recall. The old subjects had the opposite pattern and the medium age subjects performed intermediately.

Senf and Frendl (1971) replicated Senf's (1969) results in terms of finding young learning disabled children (elementary school-aged) deficient in modality recall though generally as competent in pair recall as normals on Senf's bisensory memory task. As before, the magnitude of the differences in the modality recall conditions is quite large. Some of the error measures indicated that the learning disabled children were three to four times as prone to make errors as the control group. In Senf and Frendl's study they alternated the stimuli to see if sensory masking created by the simultaneous occurrence of the auditory and visual stimuli disrupted modality recall performance. Alternating the stimuli had negligible effects. This suggest that some higher-order processes, possibly of memory organization, are involved.

Senf and Feshback (1970) compared elementary and junior high aged culturally deprived, learning disabled, and normal control readers with the same bisensory memory task. They found that older culturally deprived and normal control children ordered the digits into three audio-visual pairs when induced to do so while the learning disabled were insensitive to the set instructions. In directed recall, older culturally deprived and normal controls recalled digits in pair order more accurately than their younger counterparts. However, older learning disabled children did no better than their younger counterparts.

McKeever and Van Deventer (1975) compared a group of dyslexic and normal children (mean ages were approximately fourteen) on a dichotic listening task. The subjects were instructed to recall the digits in any order they wished. The normal subjects were significantly better in recall. Dyslexics made considerably more errors in both channels than control subjects. Also, there was significantly greater right ear than left ear recall. No interactions of groups and ears was found.

Davis and Bray (1975) investigated bisensory memory in seven to ten year old normal and reading disabled children. There were three auditory-visual digit pairs on each trial, with a one-second delay between successive pairs. After the offset of the array two of the digits were indicated by the use of recall probes. In this way a subject was directed to recall either one particular auditory-visual pair (pair condition) or two specific digits from one modality (modality condition). This was to reduce contamination by output interference. Unlike previous investigations, there was no interaction between reading groups and recall conditions on either measure. It may be that the previous finding of an interaction is due to greater output interference in the reading disability group. The finding of a reading group difference for pair and modality recall on both the order and item error measures may indicate a difference in general information processing capabilities. However, the lack of difference between pair-modality conditions for both groups on the order error measure suggests the same degree of difficulty with organization of temporal-modality information. There were significantly fewer errors for auditory than visual items with both measures.

These results suggest that reading disabled children perform less well than normal children on both a dichotic listening task and Senf's audiovisual analogue of such a task. However, the poor readers do seem to be able to take advantage of redundant information when it is provided. Next, with the bisensory task, the learning disabled children prefer the auditory modality while normal children do not seem to have a preference. Finally, there seems to be differing information concerning poor readers' ability to recall the items by pairs or by modality, relative to control subjects. Senf and Frendl (1971) provide some evidence that this may be explained in terms of an age variable with older children being more disrupted in their ability to recall by pairs. The lack of interaction effects found by Davis and Bray (1975) may be due to their elimination of output interference as they suggest. On the other hand, it may also be explained by having a group that clearly follow the pattern of young subjects.

Primary Memory

Learning theorists have designated information to which we are currently attending or to which we have very recently attended as constituting primary memory. Such activated information is readily accessible. However, there are severe limitations on the amount of information that can be activated at any one time. In examining the nature of primary memory, four important aspects are: (a) the speed for accessing items in primary memory, (b) storage limitations (both in terms of number of items and time), (c) the nature of the information in primary memory and (d) maintaining information in this stage of memory. The research literature on the memory abilities of learning disabled children that pertains to the first three of these aspects will be described below. The discussion of relevant information concerning the fourth aspect, maintaining information by rehearsal, is included in the section on secondary memory.

Access. Little research has been done with a learning disability population concerning the speed of access to information in primary memory. The one study (McKeever & Van Deverter, 1975) found that dyslexics (mean age = 13 years) were slower than control subjects in reporting a tachistoscopically presented letter. When a greater memory load and serial constraints were incorporated by requiring subjects to repeat a fixation digit and then the letter stimuli, dyslexics averaged about 146 msec. longer than the control subjects.

Storage Limitations. Most of the research concerning primary memory and learning disabled children examines the area of storage limitations. The results will be reviewed in terms of three general types of tasks: free recall, serial recall, and probed recall.

The studies using a free recall procedure have generally found that learning disabled subjects recall fewer items than control subjects. A study by Marshall, Anderson and Tate reported in Anderson and Halcomb (1976), involved presenting pictures of common objects to seven to nine year old children. The learning disabled children recalled a significantly fewer number of items. With a similar task, Egorova (1972), as reported in Crickshank and Hallahan (1975), found that first and second grade Russian learning disabled children also recalled fewer items than normal subjects. Bryan (1972) utilized a multitrial free recall problem with learning disabled and control subjects who varied in age from eight to ten years old. Half of the subjects received visual stimuli and half received auditory stimuli. The learning disabled students did significantly poorer than control subjects on this task.

Numerous serial recall tasks have been used in assessing the primary memory limits of this population. Quite a few studies have involved either an auditory or visual presentation of a digit span task (Corkin, 1974; Mason, 1975; Senf & Frendl, 1972; Spring, 1976; Stanley, Kaplan & Poole, 1975). All of these have found that learning disabled subjects remembered significantly fewer digits. Other serial recall experiments have utilized geometric shapes (Stanley, Kaplan & Poole, 1975), durational and patterns of rhythmic tones, phonemes, and words (Richie & Aten, 1976), taps on blocks (Corkin, 1974), pictures (Torgensen & Goldman, 1977), strings of consonants (Mason, 1975), and semantically and syntactically varied sentences (Wiig & Roach, 1975). The experimental groups performed less well than the control groups on all of these tasks, except memory for a series of words.

Several experiments have employed either probed recall or probed recognition tasks. Morrison, Giordani, and Nagy (1977) compared twelve year old normal and poor readers with a Sperling-type technique using letters, geometric forms, and abstract forms. Poor readers performance included a striking deficit when the probe, the indicator for what row of items was to be recalled, was presented between 300 and 2000 msec. after the stimuli ended. Spring and Capps (1974) utilized a probe recall task involving visually presented digits. The probability of correct recall was greater for the normal boys than for the dyslexic boys (age seven through thirteen years).

Nature of the Information in Primary Memory. Evidence concerning the nature of the information in primary memory comes from studies involving either errors or the manipulation of the material in memory by the subject.

Two studies have found that retarded readers tend to judge arrays as equivalent when they are not. This population, however, does not tend to judge arrays as different when they are alike. This suggests that the retarded reader's poorer performance on such tasks was probably due to a failure to maintain information concerning critical differences between stimuli. One of these experiments, by Goyen and Lyle (1973), involved a Sperling-type technique in which geometric shapes were presented tachistoscopically. Cummings and Faw (1976) conducted the other study. They presented an array of six abstract shapes to retarded and normal readers (average age = 14 years). Then they presented a comparison array at zero, one or six seconds after the original array had ended. The retarded readers did as well as the normal children in the zero delay condition. Their performance deteriorated on the one second delay. Performance then leveled off so it was essentially equal on the one second and the six second delay.

One study has examined dyslexic children's ability to manipulate spatial information in memory. The subjects were presented with pairs of pictures of three dimensional shapes like those used by Shepard and Metzler (1971). To determine whether the two pictures portrayed the same object, but at a different orientation, the subject would have to imagine one of the objects rotated into the same orientation as the other. Dyslexics and normal eight to twelve year old children did equally well at this task.

From the research reviewed it appears that learning disabled children experience numerous forms of deficits in the abilities involved in primary memory processing. For instance, learning disabled youngsters do not seem to gain access to information in primary memory as quickly as normal youngsters. The evidence for greater storage limitations is particularly well documented. In addition, learning disabled children appear to have difficulty maintaining information concerning critical differences between stimuli. Generally, the research suggests that the primary memory difficulties include processing nonverbal as well as verbal information and stimuli presented either visually or in an auditory mode. One area where a difference in primary memory abilities between learning disabled and normal children has not been found is in the manipulation of spatial information.

Secondary Memory

Various forms of processing have to occur if information is to either be maintained in primary memory or be transferred to a more long-lasting form of storage. It takes time for the operations that transfer information to a more permanent type of storage to occur. If information is lost just after it is received, there is not time for the operations to take place. Therefore, it is important that two different general types of processes take place: (a) those that maintain information in primary memory (this allows the person time to use the second form of processes) and (b) those that transform information so that it can be maintained over a period of time and retrieved easily when it is needed.

These operations have been labeled control processes. Atkinson and Shiffrin (1968) have defined them as

> . . . those processes that are not permanent features of memory, but are instead transient phenomena under the control of the subject; their appearance depends on such factors as instructional set, the experimental task, and the past history of the subject (p. 106).

Control processes are the rules and strategies a person selects, constructs, and uses in processing information. Examples of control processes include: (a) various forms of rehearsal, (b) hypothesis testing, and (c) various ways of encoding information so it will be linked with what the person already knows.

A person's ability to utilize various control processes depends to a large degree on more basic abilities. These abilities, that will be called basic processes, are the building blocks for control processes. Basic processes include: (a) rate of vocalizing, (b) one's ability to switch attention, (c) the ability to encode and classify percepts, (d) the ability to look at a perceptual cue and imagine it in another form, (e) the ability to create and use mental images, and (f) one's primary memory capacity. These are basic abilities that a person can tap and combine for the control processes they decide to use. Therefore, one's abilities in terms of these basic processes may make possible or limit what control processes one can use effectively.

The research on aspects of secondary memory in learning disabled children will be examined in terms of the types of control processes that seem to be involved. First, serial position curves will be covered to see if difficulties occur in the operations that maintain information in primary memory and/or the operations that are used in transferring the information from primary memory to a longer lasting form. The specific control processes that will be covered include: chunking, categorizing, rehearsal elaboration, and mediation.

Serial Position Curves. The research with learning disabled children that presents serial position information generally indicates that a recency effect occurs but a primacy effect is not present. Traver, Hallahan, Kauffman and Ball (1976) administered Hagen's Central-Incidental task to young learning disabled and normal boys (mean age = 8.6 years). On the serial position curve both normal and learning disabled subjects showed a recency effect but only normals showed a primacy effect. In another experiment, the same task was used with intermediate (mean age = 10.2 years) and older (mean age = 13.5 years) learning disabled boys. In this experiment there was a standard condition and a verbal rehearsal condition where the child was required to label, chunk, and rehearse the items. Primacy and recency effects were found for all four groups.

Weber (1975) presented either visually or auditorily a series of seven digits to learning disabled and matched subjects (mean age = 9 years). From looking at the serial position curves, he found primacy and recency effects for both groups. However, there was less of a primacy effect for the learning disabled subjects. Later Weber trained the subjects three times a week for six weeks with one of three strategies: chunking, learning a number of digits by adding them one at a time to the string of digits already known, and a control treatment. The training in rehearsal strategies did not produce a significant differential improvement in primacy performance.

A study by Marshall, Anderson and Tate in Anderson and Halcomb (1976) utilized a single trial free recall task to compare learning disabled and normal subjects that ranged in age from seven to nine years. The experimenters found that the serial position curves for the two groups were similar. However, when the subjects were divided into young (mean = 7 years) and old (mean = 9 years) groups, the curves were different. For normal subjects, the primacy effect increased with age while the recency effect did not. For the learning disabled subjects, the primacy effect remained the same but the recency effect was greater for the older subjects. This brought the older learning disabled youngsters closer to the older normal subject's level of recall for the last positions.

Spring and Capps (1974) presented a probe-recall task to seven through thirteen year old dyslexic and normal boys. During the task the experimenter watched the eye movements of the subjects to detect scanning efforts. The results indicate that (a) almost all of the normal subjects but barely half of the dyslexics employed left-to-right visual scanning during the probe task (supposedly indicative of cummulative rehearsal), (b) primacy effects were present for normals and dyslexic scanners but not for dyslexic non-scanners, and (c) the probability of correct recall was greater for normals than dyslexics in all but the last two serial positions.

The presence of recency effects in the results suggest that learning disabled children utilize the control processes involved in maintaining information in primary memory. The fact that the serial position curves even in the last positions are generally lower for learning disabled than normal subjects suggests that the learning disabled children may be less efficient at the use of such processes. The lack of primacy effects in the results of learning disabled children's performances implies that these youngsters are quite inefficient at utilizing the control processes involved in the transfer of information in primary memory to a more permanent form of storage.

Control Processes. Craik and Watkins (1973) have divided control processes into two general types: maintenance rehearsal and elaborative operations. Maintenance rehearsal is repeating the information over to oneself. The form or organization of the material is not changed. Elaborative operations generally involve working with the material in some way. In doing so, the organization of the new information may be changed and associations between the new material and what the person already knows may be made.

Studies with learning disabled children where maintenance rehearsal instructions are utilized generally find that these children can rehearse (even though they may do so less than normal children). Conaway (1976) presented nonsense syllables to normal and learning disabled subjects (eight to thirteen years old). Control and forced rehearsal conditions were studied. The subjects were asked to recall the trigrams after delays of 3, 6, 9, 12, or 18 seconds. From the results the author concluded that learning disabled children have the capacity to rehearse effectively but generally fail to utilize this ability when faced with a short-term recall task.

Torgensen and Goldman (1977) compared normal and reading disabled late-second grade children on a short-term memory task. During a delay period on the task the experimenter observed the children for signs of verbal rehearsal. A second similar task was then given and the children were instructed to say aloud the names of the items during the presentation and recall phases. This has been found by Flavell (1966) to increase the use of rehearsal for children who did not spontaneously do so. On the first task good readers verbalized significantly more and achieved significantly higher recall scores. The reading-disabled group made significant improvements between the first and second tasks on both the number of verbalizations and the total recall score.

Several studies have been done where maintenance rehearsal instructions have not significantly improved the performance of the learning disabled children on the experimental task. Two of these studies can be explained in terms of tasks requiring the use of secondary memory. For those studies (Weber, 1975; Bryan, 1972) maintenance rehearsal was not particularly appropriate.

The elaborative operations that will be examined in this paper are: chunking, categorizing, and elaborative rehearsal. Chunking changes the nature of the information by the subject actively engaging in a process of grouping the items. Chunking has not been studied with a learning disabled group separate from other control processes. Tarver, Hallahan, Kauffman, and Ball (1976) found that having young learning disabled boys label, chunk, and verbally rehearse items on Hagen's Central-Incidental task improved performance significantly. Weber (1975) found that chunking tended to help nine year old learning disabled boys remember visually presented seven-digit series, but not to a significant degree.

Two studies have looked at the extent learning disabled subjects group items. Cruickshank and Hallahan (1975) describe a study by Egorova (1972) where second and third grade Russian learning disabled and normal children were presented with an immediate recall task. Egorova found that the learning disabled children grouped a much smaller percentage of the remembered items than the control subjects.

Parker, Freston, and Drew (1975) looked at the degree ten year old learning disabled and normal children used the input organization of the material to aid learning. The stimuli consisted of lists of five words that were either from one conceptual category (for example, animals) or from several categories. Normal subjects recalled significantly more items than learning disabled subjects. Material organization was a significant factor for the normal subjects but not for the learning disabled subjects. The experimenters suggested that the learning disabled subjects failed to use implicit retrieval cues.

One form of elaborative rehearsal that has been found quite helpful for normal adults are mnemonic strategies (Norman, 1976). Although several authors (Lerner, 1971; Ross, 1976; Shoemaker, 1971) suggest that mnemonic techniques be used with learning disabled children, studies do not seem to have been done in this area.

In examining the research on the secondary memory abilities of learning disabled children, it is evident from serial position curve studies that these youngsters do less well than their normal peers at getting information into secondary memory. This appears to be particularly due to the limited use learning disabled children make of maintenance rehearsal processes. Little has been investigated in terms of learning disabled children's use of elaborative rehearsal types of operations. From what has been done it appears that these youngsters make limited use of cues for grouping items.

Mnemonics to Aid Memory

Over the centuries humans have been concerned with the art of memory. As part of this process, a number of special techniques for remembering material have been devised. In the past psychologists have largely ignored one group of these techniques, mnemonic devices. Psychologists have tended to consider these mere tricks and sophistry utilized by stage entertainers or included in questionable commercial memory courses and books. However, when one looks further it is found that the techniques do aid memory, have a long and significant history of use, have been investigated by psychologists at earlier time periods, and involve some basic principles of learning. Each of these points will be elaborated upon.

Mnemonic Techniques are Effective

Several investigators have demonstrated that mnemonic processes and strategies facilitate memory (Delin, 1968; Luria, 1968; Senter & Hauser, 1968; Smith & Noble, 1965; Wood, 1967). Neisser (Sheehan, 1972) has noted that particularly those mnemonic strategies that include the use of mental imagery seem to have very striking results. The two mnemonic-imagery strategies that psychologists appear to have studied the most are called the method of loci and the pegword system. The method of loci involves forming an image for the first item of an ordered list. The image is ten imagined in the first room of a house or building. The image for the second item is placed in the second room. To recall the items in their correct order one takes a mental walk through the house and "sees" each image in the successive rooms. Dramatic results have been obtained from experiments comparing a control group using their normal means of learning a list of items versus subjects using the method of loci. Experimental subjects have remembered two to seven times as much as control subjects (Bower, 1970). Experimenters verifying the effectiveness of the method of loci include Ross and Lawrence (1968) and Crovitz and his collaborators (Briggs, Hankins & Crovitz, 1970; Crovitz, 1964). Withe the pegword mnemonic technique the words to be remembered are paired serially with a rhyme, i.e., "one is a bun, two is a shoe, three is a tree." Recall seems to be helped by the number evoking the mnemonic mediator which then elicits the word to be remembered (Bugelski, 1968; Bugelski, Kidd &Segmen, 1968). Paivio (1968) has shown that imagery is necessary for this mnemonic system. By itself, the mnemonic rhyme is insufficient to mediate retrieval.

Historical Use

Yates (1966) has shown that mnemonic strategies have been part of the intellectual tradition of the west for over 2000 years. For instance, the method of loci dates back to ancient Greece. The device enabled orators to remember numerous speeches. It helped the speaker correctly recall both all the parts of the speech and the parts in their correct order.

Previous Psychological Investigations

Brown and Deffenbacher (1975, p. 342) have pointed out that there is within experimental psychology ". . . a modest historical literature on the subject" of exceptional memories. They then describe the work of Binet, Müller, Hegge, and Susukita. Alfred Binet appears to have conducted the first extensive experimental study of mnemonists. Binet tested the calculators Inaudi and Diamandi at various memory tasks including digit memorization and at mental arithmetic. Binet also tested Arnould, a user of an artificial memory system. Next, Georg Müller performed a series of experiments in 1906 and 1912 on a mnemonist and mental calculator, G. Rückle. Thorlief Hegge presented studies of another mnemonist, a female Norwegian philologist, Berg. Finally, in a pair of lengthy articles, Tukasa Susukita reports experiments with Isihara, a stage mnemonist. These articles include detailed examinations of mnemonic processes as well as comparisons with Binet and Müller's results.

Brown and Deffenbacher (1975) propose four possible reasons why the various early studies of mnemonists have been largely forgotten. First, the earlier literature may have seemed irrelevant to the concerns of more recent psychologists. Secondly, it may be due to the research not being well known. Brown and Deffenbacher remark that this may apply to Susukita but it does not seem to fit Binet or Müller. Thirdly, the earlier works may have used different terminology than a more recent reader might have in mind. Fourthly, the research problems and methods may not have been acceptable to psychologists during the earlier decades of the twentieth century. This reason certainly seems relevant to Müller. In contrast, present day American psychologists seem to have expanded the topics and methods they accept to the point where a growing interest in mnemonics in general and these earlier works is appearing.

Psychological Principles Involved

What is it concerning mnemonic systems that improves one's ability to remember? After examining psychological research findings concerning memory as they relate to mnemonic systems, Norman (1969) concludes that the power of these systems appears to be the result of a very simple principle:

> . . . they reduce long, unrelated strings of material into short, related lists. Mnemonic systems provide us with the rules and techniques for shortening the sequence that is to be learned and finding meaning, even where there appears to be none (p. 121).

They all have the user pay careful attention to the material, organize the items, and relate what is to be learned to things the individual already knows. If the new material can not be easily related to known facts through visualizations and associations, the new information ". . must be transformed by the use of key words or analytic substitutions until images can be used" (Norman, 1969, p. 118).

The importance of these processes can be understood in terms of known properties of human memory. The emphasis on the structuring of stored material relates to the retrieval problems with a large capacity system. Slowly psychologists have begun to realize that subjects in their experiments frequently group the items they are to learn.

Bousfield (1953), Bousfield and Cohen (1955) and Bousfield and Sedgewick (1944) noted clustering when subjects recalled words. Tulving (1962, 1964) found that subjects organize the words they are to learn and recall them according to the same organization. After reviewing such studies Norman (1969) concluded that it is not easy for humans to learn material unless it has structure. If structuring is not present, humans impose it. Moreover, the limitations of primary memory determine the possible type of organization in secondary memory. This can be seen in the use of a limited number of small units (Miller, 1956).

Norman (1976) has formed four basic rules for efficient memorizing, based on what is known about human memory. The rules are:

1. Small basic units. The material to be learned must be divisible into small, self-contained sections, with no more than four or five individual items in any section.
2. Internal organization. The sections must be organized so that the various parts fit together in a logical, self-ordering structure.
3. External organization. Some relationship must be established between the material to be learned and material already learned.
4. Depth of processing. Any mental activity performed on the material, such as forming images or putting it into mental settings or stories, increases the depth of processing, thereby automatically helping to form the relevant connections that improve retrievability (p. 154-155).

Mnemonic strategies clearly provide systematic techniques for working with material in a way that follows these rules.

Mnemonic Techniques Have Helped Other Specialized Populations

Although several authors (Lerner, 1971; Ross, 1976; Shoemaker, 1971) have suggested that mnemonic techniques be used with learning disabled children, previous research in this area does not appear to have been done. However, research has been done showing mnemonic techniques to be helpful for other specialized populations. For instance, mediational strategies, often clearly capitalizing on the use of imagery, have been shown to be effective with educably mentally retarded children (Burger & Blackman, 1976; Taylor, Josenberg & Knowlton, 1972; Wanschura & Borkowski, 1974; Yarmey & Brown, 1972) and retarded adults (Lebrato & Ellis, 1974; Zupnick & Meyer, 1975). Another study demonstrated that imagery instructions served to improve the memory of blind adults (Jonides, Kahn, & Rozin, 1975). Finally, Pattern (1972) found that a mnemonic devise, the pegword system, significantly helped four of seven patients with brain function impairment related to such factors as encephalitis and a frontal arteriovenous malformation.

Evidently mnemonic devices have been utilized for hundreds of years. Psychologists have studied them sporadically since the end of the last century. Research supports the effectiveness of many of these devices both for normal adults and specialized populations. Finally, the basis for their effectiveness is quite clear when they are examined in terms of how they fit what is known about efficient memory in humans with their large capacity store.

The Mnemonic Keyword Method

In conducting foreign language vocabulary learning experiments, Richard Atkinson (1975) has been struck by the great variability in learning rate across subjects. He indicated that this may reflect differences in fundamental abilities, but

> . . . it is easy to demonstrate that they also depend on the strategies that subjects bring to bear on the task. Good learners can introspect with ease about a 'bag of tricks' for learning vocabulary items, whereas poor learners are incredibly inept when trying to describe what they are doing (p. 821).

As a result of these observations, Richard Atkinson and Michael Raugh have been developing and experimenting with the keyword method, a mnemonic procedure for learning foreign language vocabulary. Their studies have shown the method to be remarkably effective both with Spanish and Russian words and both in the psychological laboratory and as a supplement to a college foreign language curriculum (Atkinson, 1975; Atkinson & Raugh, 1975; Raugh & Atkinson, 1975; Raugh, Schupbach & Atkinson, 1977). In presenting this method the following areas will be covered: (a) a description covering how the method works and the criteria for the selection of the "keywords" used, (b) a presentation of the results of the psychological studies concerning its use, and (c) a discussion of the best ways to use the keyword method and why these conditions have been selected.

Description of Method

The keyword method is a mnemonic procedure for associating a spoken foreign word and its English translation. With this method, the study of the word is divided into two stages. In the first stage, the spoken foreign word is associated with an English word that sounds similar to some part of the foreign word. For example, the Spanish word caballo (pronounced somewhat like "cob-eye-yo"), includes a sound similar to the English word "eye." The similar sounding English word is referred to as a keyword. Usually the only relationship between the keyword and the foreign word is the similar sound. In the second stage of this method, the subject forms a mental image of the keyword interacting with the English translation. To continue with the example given previously, caballo (meaning horse) would be linked by the forming of a mental image like a cyclopean eye winking in the center of the forehead of a horse or a horse kicking a large eye. In essence,

> . . . the keyword method can be described as a chain of two links connecting a foreign word to its English translation through the mediation of a keyword. The foreign word is linked to the keyword by a similarity in sound (the acoustic link); in turn the keyword is linked to the English translation by a learner-generated mental image (the mnemonic or imagery link) (Raugh, Schupbach, & Atkinson, 1977, p. 200).

The procedure generally used by Atkinson and Raugh has been to present a series of foreign words to the subject. As each foreign word is pronounced the experimenter displays its keyword and English translation. While each item is presented the subject has to both (a) associate the sound of the foreign word with the keyword given and (b) generate a mental image that involves the interaction of the keyword and the English translation.

After studying independent measures on the effectiveness of various keywords, Atkinson and Raugh (1975) stress a careful selection procedure for the keywords used. Generally a panel of individuals familiar with the keyword method are used to select the keywords. The criteria that they use to determine if a keyword is eligible are:

1. The keyword sounds as much as possible like a part (not necessarily all) of the foreign word.
2. It is easy to form a memorable imagery link connecting the keyword and its English translation.
3. The keyword is unique (different from other keywords used in the vocabulary) (Raugh, Schupbach & Atkinson, 1977, p. 200).

The first criteria makes possible flexibility in the choice of keywords, since any part of the foreign word could serve as the key sound. Therefore, with a polysyllabic foreign word, the keyword could range from a monosyllable, to a longer word, to even a phrase that covers the entire foreign word. The second criteria stresses the importance of a simple memorable imagery link. Concrete nouns are often used since frequently they are especially easy to image. Furthermore, the keyword must not only be easily imaged but also be imageable in a relationship with the English translation. The third criteria is included so that ambiguities will not be engendered by having a keyword associated with more than one foreign word.

Results of Research on the Keyword Method

Atkinson and Raugh have done a number of studies on the effectiveness of the keyword method. One experiment involved 120 Spanish vocabulary items including ones that were judged to be difficult to image. The test vocabulary was divided into three comparable subvocabularies which were presented by computer on three consecutive days. A test covering all the items was given two days after the presentation of the last subvocabulary. A similar test was given one month later. For the keyword and control conditions, respectively, the results were 54% and 45% correct ($p < .001$). With the delayed comprehensive test, the results were 43% and 35% correct, respectively ($p < .01$) (Raugh & Atkinson, 1975).

In another experiment all the subjects were first taught the keyword for each item in a 60-word Spanish vocabulary. The subjects were then divided into an experimental and control group. The experimental group was instructed to use imagery to associate each keyword with the English translation. The control group used a rehearsal method to associate each Spanish word directly to its English translation. With this test of the effectiveness of mental imagery, 88% and 28% of the words were recalled correctly by the experimental and control groups, respectively (Raugh & Atkinson, 1975).

In a third study subjects were in one of three conditions. One group used the keyword method. A free-choice group could use whatever learning strategy they preferred, which included requesting a keyword when desired. The control group used a rehearsal method to learn the 120 items. The percentages of correct responses on a comprehension test were 59%, 57% and 50% correct for the free-choice, keyword, and control conditions respectively ($p < .005$) (Raugh & Atkinson, 1975).

Next, the effectiveness of the keyword method was tested on a non-Romance language, Russian. Russian posed a special challenge since it involves a number of frequently recurring phonemes that do not occur in English. A subvocabulary was presented by means of a computer on three consecutive days. On the fourth day a comprehensive test of the 120 items was given. The percentages of correct items on this test were 72% and 46% correct for the experimental and control groups respectively ($p < .001$). Then without warning, subjects were called back six weeks later for a second comprehensive test. On that test the keyword group recalled 43% of the words and the control group recalled 28% of the items. The average performance when an English phrase served as the keyword was the recall of .74 of the items for the keyword condition and .44 for the control condition on the comprehension test. The corresponding averages for items with the keyword consisting of one English word were .71 and .45 respectively. Therefore, the probabilities were essentially equal for learning the keyword-phrase items as the single-keyword items (Atkinson, 1975; Atkinson & Raugh, 1975).

Raugh, Schupbach and Atkinson (1977) evaluated the keyword method for teaching a large Russian vocabulary (675 words) over eight to ten weeks. A computer controlled keyword curriculum was a supplement to a second-year Russian language course at Stanford University. They found that the students frequently chose to use the keyword method and that it seemed quite effective.

Utilization of the Keyword Method

Finally, several procedural considerations and possible criticisms of the keyword method will be considered. Based on their experiences, Raugh and Atkinson (1975) have outlined four procedures that seem to facilitate learning foreign vocabulary when the keyword method is used. First, they suggest that the experimenters provide the keywords rather than having the subject generate his own. This is especially important if the subjects are unfamiliar with the phonetics of the foreign language. Secondly, it is better to have the subject create his own imagery link rather than having the experimenter suggest one. This suggestion corresponds with Bower's (1972) observation that natural language mediators that are generated by the subject, rather than the experimenter, are more effective in the learning of paired associates. Thirdly, the keyword selected needs to approximate enough of the sound of the foreign word to distinguish it from other words in the list. It is not necessary to approximate the full sound of the foreign word. Fourthly, pilot work has been done concerning the recall of a foreign word given its English translation. This work suggests that this type of recall is easier if the keyword approximates the first syllable of the foreign word.

Conclusion

Finally, the use of the keyword (as enabling an imagery link process) can be conceptualized as a temporary crutch utilized in the initial learning of a foreign vocabulary word-English translation pair. Based on his research using the keyword method with Russian vocabulary, Atkinson (1975) indicates that early in the learning process for a pair, the learning of an item consists of two independent links, one acoustic and the other imaginal. However, with continued practice a third link is formed that directly associates the foreign word and its English translation. At this point the subject will only use the keyword under special circumstances, such as when he is consciously trying to do so or when he fails to retrieve the information by the third link process. The advantage of the less direct chain of the acoustic and imagery links is that they serve as a crutch in the subject's learning of the direct association. This view is supported by Atkinson's (1975) research which found that once an item was thoroughly mastered, retrieval times did not differ for subjects that learned it by the keyword method or by rote rehearsal.

When subjects in a keyword group and rote rehearsal group studied items to the same criterion level, it was found that learning by use of the crutch not only facilitates foreward associations but also backward associations. On retrieval of a Spanish word given its English translation, Atkinson (1975) found that the keyword group had a score 19% above that of the rote-rehearsal subjects. This is despite the fact that the keyword group had fewer learning trials on the foreward association than the rote-rehearsal group since the keyword group was faster at reaching the criterion.

From observations in a study entitled "The Effects of Interactive-Image Elaboration on the Acquisition of Foreign Language Vocabulary" (Ott, Butler, Blake & Ball, 1973), there is some evidence to suggest that students use mediating strategies similar to the keyword method as a crutch when learning foreign vocabulary, even if not instructed to do so. They report that subjects not given special instructions often employ English mediating words combined with imagery or other mnemonic aids. These observations suggest that the keyword method is not essentially different from techniques frequently used by subjects. The primary differences are (a) the extent to which the method is applied and (b) that the experimenter supplies a carefully selected keyword.

Rationale for the Present Study

From the research that has been done, learning disabled children clearly have memory difficulties. Compared to normal children learning disabled youngsters show some small decrement in their abilities to process information at the sensory memory level and to transfer the information into primary memory. However, the substantially larger drop in performance occurs on tasks that require transferring information to and retrieving information from long-term storage.

Mnemonic techniques, like the keyword method, have been demonstrated to help normal adults with remembering material for a period of time and easily retrieving the information when they need it. This study will investigate whether the keyword method will also aid learning disabled children in this way. The first hypothesis is that the learning disabled children who have been taught the keyword method will learn a significantly greater proportion of a list of Spanish vocabulary items and their English meanings than control subjects. The second hypothesis is that the subjects using the keyword method are expected to recall more than the control subjects of the English meanings when the test follows a short post-study delay period where the child does several quick cognitive tasks.

A third major emphasis is to gain a better understanding of individual differences in rate of learning paired associates with or without the keyword method. To this end a number of exploratory correlation matrices were employed. Three sets of variables seemed most valuable for such matrices: (a) demographic variables such as age, scores on an intelligence test, and scores on an achievement test, (b) performance measures on seven short tasks designed to evaluate basic processes such as switching attention and the use of visual imagery, and (c) measures on the various phases for learning the pairs of Spanish words and their English meanings. An examination of the correlation matrices for (a) tasks that vary together and (b) tasks which seem to be relatively independent of each other may reveal what types of abilities learning disabled boys need in order to effectively utilize the keyword method. Patterns found in the exploratory section may also suggest areas for further research related to this study that would be extremely valuable.

CHAPTER II

METHOD

Subjects

Forty boys served as subjects. They ranged in age from eleven through seventeen (Mean = 13.73, Standard Deviation = 1.38). The boys were in the sixth through the eleventh grades (M = 7.88, S. D. = 1.28). All had been diagnosed as learning disabled according to the criteria used in the State Of Oklahoma. To be identified as learning disabled in that state, the student must show below expectancy achievement in one or more curriculum areas, a normal intelligence, and the assumption of a neuropsychological factor as the basis of the learning disability. Learning problems due to major sensory or motor defects, mental retardation or cultural deprivation are not identified as learning disabilities. Many of the characteristic of the sample used in this study are portrayed in Table V. That table presents the means and standard deviations for the entire sample and separates the control and mnemonic groups on a number of measures of demographic factors. In fitting with this criteria for being learning disabled, all the subjects had at least a full scale score of eighty-five on the Wechsler Intelligence Scale for Children-Revised (WISC-R), (M = 93.20, S.D. = 6.42). The average score on the verbal section of the WISC-R was 89.13 (S.D. = 8.22). For the performance section of the WISC-R the average score was 99.98 (S.D. = 8.06). In terms of year in school, the subjects were an average of 1.05 grades

(S.D. = .905) behind the usual grade level for their age. In academic achievement, the average grade level on the Wide Range Achievement Test (WRAT) reading section was 4.66 (S.D. = 1.63). For the WRAT arithmetic test the mean grade level was 4.51 (S.D. = 0.95). The mean on the WRAT spelling test was 3.56 (S.D. = 1.02). Figures 4,5, and 6 (Appendix A) are graphs which clearly show that most of the subjects performed below their grade level on each of the three WRAT tests. Finally, each subject spoke English as his native language and had not previously studied Spanish. Twenty subjects were randomly assigned to the control and experimental groups.

Stimulus Materials

Thirty-six Spanish nouns and their English translations were used. Three of the items were used in the baseline instructions. Fourteen items comprised the baseline list. Five more items were utilized in the instructions for the experimental phase. Fourteen other items and their keywords were used in the experimental phase. All the Spanish words and their keywords had been previously used by Raugh and Atkinson (1975). Those experimenters had judged all the English translations as easy to image. An example of some of the items used is presented in Table I. All the stimuli were type in capitals on an eight inch (20.2 cm.) by five inch (12.7 cm.) card. The Spanish words were typed in the center of the card. Figure 7 (Appendix B) presents a typical front side of a card for the baseline (both goups) and for the experimental list for the control group. When a keyword was presented, it appeared in parentheses to the right and below the Spanish word. Figure 8 (Appendix B) is an example of such a card. The English translations were placed in the

TABLE I

A SAMPLE OF THE SPANISH VOCABULARY ITEMS USED

Spanish Word	Keyword	English Meaning	Image Given To Mnemonic Group
Arroz	(Rose)	Rice	Picture a pretty red rose with puffed rice shooting out of it.
Cubeta	(Cube)	Pail	Picture a pail filled to the top with ice cubes.
Jabon	(Bone)	Soap	See yourself starting to wash your hands. You reach your soap and find a bone in the soap dish.
Mujer	(Hair)	Woman	Picture a woman with long flowing pretty hair. She is combing her hair.

center on the back of the card. Figure 9 (Appendix B) shows the typical back side of a card for either the baseline or the experimental list.

Procedure

The session with each subject started with a few minutes of informal conversation to establish rapport. During this time, an opening statement was made that this was an experiment to test memory for Spanish vocabulary items and their meaning in English. Then, each subject participated in the five aspects of the experiment: a baseline rote learning procedure, a teaching period, learning an experimental list, a few minutes of interpolated activities, and finally a delayed recall test over the experimental list. Table II presents the different phases of the experiment in their order of occurrence. Each phase will now be described. References to Table II will be made to help clarify the verbal descriptions. The exact instructions used in each phase can be found in Appendix C.

Baseline Phase

In the instructions for the baseline phase, each subject was told that (a) he would be shown a series of Spanish words and their English meanings and (b) after seeing the series he would be given a recall test where the Spanish word would be shown and pronounced and he would be asked to give the English meaning. Three items were used to illustrate both the study and the test aspects. With these example items, the subject was shown a Spanish word typed on a card and the word was pronounced twice in a three second period. Two more seconds passed while the card was turned over revealing the English meaning. The English meaning was

TABLE II

DETAILED DIAGRAM OF THE PHASES OF THE EXPERIMENT

Baseline Phase	→	Teaching Period	→	Experimental Phase: Control or Mnemonic Procedure	→	Interpolated Activities: Basic Process Tasks	→	Delayed Recall Test

<table>
<tr><th rowspan="2">Phases</th><th colspan="2">Group</th></tr>
<tr><th>Control</th><th>Mnemonic</th></tr>
<tr><td>Baseline Trials</td><td>Example "Tijeras"→"Scissors"

Study { Stimulus 1→Response 1
S 2 → R 2
S 3 → R 3
⋮ ⋮
S 14 → R 14

Test { S 1 → ?
S 2 → ?
S 3 → ?
⋮ ⋮
S 14 → ?</td><td>

Same as for Control Group</td></tr>
<tr><td>Teaching Period</td><td>One study-test trial over a list of five items was given. The items were in the same order for the study and test aspects. These are the same items that the experimental group works with in this part of the experiment.</td><td>The first two items were used as examples in the explanation of the keyword method. The subjects practiced using the keyword method in studying three more items. The subjects were then tested over the five items.</td></tr>
</table>

TABLE II (CONTINUED)

Phases	Group	
	Control	Mnemonic
Experi- mental Period	Example "Jabon"⟶"Soap"	"Jabon"⟶"Bone"——"Soap"
	Stimulus 20 Response 20 Study { S 21⟶R 21 S 22⟶R 22 ⋮ ⋮ S 34⟶R 34	Study { S 20⟶Keyword⟶R 20 S 21⟶Keyword⟶R 21 S 22⟶Keyword⟶R 22 ⋮ ⋮ ⋮ S 34⟶Keyword⟶R 34
	Test { S 20⟶? S 21⟶? S 22⟶? ⋮ ⋮ S 34⟶?	Test { S 20⟶Keyword⟶? S 21⟶Keyword⟶? S 22⟶Keyword⟶? ⋮ ⋮ ⋮ S 34⟶Keyword⟶?
Basic Process Tasks	The seven basic process tasks.	The seven basic process tasks.
Delayed Recall	Example "Jabon"⟶? S 20⟶? S 21⟶? S 22⟶? ⋮ ⋮ S 34⟶?	"Jabon"⟶?⟶? S 20⟶?⟶? S 21⟶?⟶? S 22⟶?⟶? ⋮ ⋮ ⋮ S 34⟶?⟶?

also pronounced twice in another three second period. Approximately five more seconds passed as the card was removed and another card was introduced. For the example given in the baseline phase in Table II, tijeras would be presented and pronounced twice. The card on which the item was typed would be turned over revealing the English meaning, "scissors," which would then be pronounced twice. That card was removed and the next card with a different Spanish word was presented. The first baseline study trial was then presented in the same way. The procedure continued until the subject had a chance to study all fourteen pairs (presented as Stimuli 1 through 14 and Responses 1 through 14 in Table II). Then the recall test occurred where the Spanish word was presented and pronounced. The subject was then allowed approximately fifteen seconds to give the English meaning. As soon as the first study-test trial was finished the stimulus cards were shuffled and the second study-test trial was started. Both trials were presented in the same manner.

Teaching Period

The next section, the teaching period, differed for the control and mnemonic groups. For the control group, five Spanish words and their meanings were presented as a practice list. One study-test trial similar to the baseline procedure was given. In this instance the items were presented for the study period and the test in the same order. It was at this time that the mnemonic group was taught the keyword method. The keyword method was presented as a memory aid involving a "linking word," an English word that sounds like part or all of a Spanish word. As illustrations, the subjects were shown two Spanish words, their keywords, and their English meanings. An example of a mental picture that one might form involving the keyword and the English meaning was given for each item. The subjects were asked to create and describe the mental picture for each of the two items. Three more items were used as a practice list. For each of these, a picture was described to the subjects. They were asked to make the picture in their minds and to describe it to the examiner when they saw the picture clearly. After forming pictures for the practice list the subject was tested over the list. If he had difficulty with the method further coaching was given. The five items used as the illustrations and practice words were the same as those used as a practice list by the control group.

Experimental Phase

For the experimental part of the study the subjects were given two study-test trials over another list of fourteen items. The order of the items was randomized for each trial. For the control group a similar procedure to that used in the baseline phase was utilized. The one difference occurred on the study part of the first trial. The subjects were given approximately nine seconds (instead of the three seconds used on the baseline phase) to look at the English meaning. This was done to be consistent with the mnemonic group, where the additional time was needed to form the mental image. In the experimental phase the subjects in the mnemonic group were instructed to use the memory aid in learning the items. The cards for the study and test trials had the keywords typed below the Spanish word. In the presentation of the items the Spanish word was pronounced twice (as in the baseline phase) and then the keyword was pronounced once. In the study part this was followed by the presentation and pronouncing of the English meaning. A picture linking the keyword and the English meaning was described next. The subjects were instructed to nod their head when they had formed the picture in their mind. The images were given, rather than having the subjects form their own, in order to keep the time spent in forming the images short and equivalent for the various subjects. To illustrate the mnemonic group procedure, the example item from Table II will be used. That is, a subject would be shown the word jabon and it would be pronounced twice. Then the keyword, "bone," would be pronounced. The card would be turned over and the English meaning, "soap," would be shown and pronounced twice. The subjects were told "See yourself starting to wash your hands. You reach for the soap and find a bone in the soap dish." After they had nodded their head to indicate that they saw the mental picture clearly, the examiner would move on to the next item. In the test trials, the subject was expected to recall the English meaning after the Spanish word and keyword were presented and the Spanish word had been pronounced.

Basic Process Tasks

The basic process tasks were presented for approximately five minutes at this point in the session. They were designed to measure the processes which seem to serve as the building blocks for what Atkinson and Sheffrin (1968) have called control processes. Table III gives the names and explanations of the seven tasks. Table IV explains three other measures that were derived from the subject's time scores on the basic process tasks. The first three tasks listed in Table III - Speak, Mouth, and Alter - are related to each other in that they all involve moving one's mouth as if to say the letters of the alphabet. Both the

TABLE III

THE BASIC PROCESS TASKS

Task	Explanation
(1) Speak	When the experimenter said "start," the subject said the alphabet as quickly as possible. The subject finished by saying "stop." Subject says: "a, b, c, . . .x, y, z, stop" Dependent Variable: the number of seconds between the time when "start" and "stop" are said
(2) Mouth	When the experimenter said "start," the subject moved his mouth as if to say the letters of the alphabet but did not say them out loud. The subject finished by saying "stop" out loud. Subject says: "(a), (b), (c), . . .(x), (y), (z), stop" when the letters in parentheses indicate that they are mouthed Dependent Variable: the number of seconds between the time when "start" and "stop" are said
(3) Alter	When the experimenter said "start," the subject went through the alphabet alternating between saying a letter and mouthing the next. The subject finished by saying "stop" out loud. Subject says: "a, (b), c, (d), e, (f), . . .(x), y, (z), stop" Dependent Variable: the number of seconds between the time when "start" and "stop" are said
(4) Percept	The subject was given a card with the alphabet typed in small letters on it. When the experimenter said "start," the subject went through the alphabet (while looking at the card) and said "yes" for each letter that was tall (took more than half of a typed space) and "no" for each letter that fit in half of a typed space. Subject says: "no, yes, no, yes, no, . . .no, yes, no"

TABLE III (Continued)

Task	Explanation
(4) Percept (Continued)	Dependent Variables: the number of seconds between the time when the experimenter said "start" and when the subject finished classifying the letters the number of mistakes and omissions made by the subject
(5) Translate	The subject was given a card with the alphabet typed in capital letters on it. When the experimenter said "start," the subject went through the alphabet and classified the small letters as tall or not. The subject could look at the card to remind him of the letters. He was to say "yes" for tall letters and "no" for letters that were not tall. Subject says: "no, yes, no, yes, no, . . .no, yes, no" Dependent Variables: the number of seconds between the time when the experimenter said "start" and when the subject finished classifying the letters the number of mistakes and omissions made by the subject
(6) Image	The subject was told to imagine the small letters of the alphabet and classify them as tall, saying "yes," or not tall, saying "no." Subject says: "no, yes, no, yes, no, . . .no, yes, no" Dependent Variables: the number of seconds between the time when the experimenter said "start" and when the subject finished classifying the letters the number of mistakes and omissions made by the subject

TABLE III (Continued)

Tasks	Explanation
(7) Span	The subject was told that after the experimenter read a list of letters, the subject was to write down as many as he remembered in any order. The experimenter read a list of twelve consonants at the rate of one every two seconds. Dependent Variable: the number of consonants from the list written down by the subject

TABLE IV

MEASURES DERIVED FROM THE BASIC PROCESS TASKS

Measure	Derivation
(1) Switch	Switch Alter - (Speak + Mouth)/2
(2) Change	Change = Translate - Percept
(3) Imagery	Imagery = Image - Percept

Speak and Mouth tasks measure the rate one can say or mouth a list of items. This is an ability that is likely to influence the rate at which one can rehearse a list. Alter is designed to tap one's ability to alternate between overt and covert modes of expression. Such an ability is likely to be used when one switches between the use of internal information, such as mental images, and overt expression such as saying the information out loud. Another valuable score, the time the subject requires to switch between modes, can be derived from these measures. Table IV presents how Switch is calculated. The relative speed with which one can switch their attention is probably an important basic process.

The next three task - Percept, Translate, and Image - are related in that they all involve encoding and classifying visual/spatial aspects of a list of stimuli. Percept is the easiest task because the stimuli to be classified are actually present. This is a relative measure of the ease with which a subject can abstract and classify perceptual information. The Translate task is more complicated because another dimension is added to the Percept task. That is, the subject is given the percept in one form (capital letters) but has to translate them in his mind into another form (small letters) before the task can be completed. By subtracting a subject's time on the Percept task from their time on the Translate task a measure called Change (Table IV) is derived. Change estimates the subject's relative ease in changing a percept into a mental image in another form. This basic ability is probably important for the use of imagery in learning and remembering material. The Image task (Table III) requires that the subject both form mental images of the percepts and recall the percepts from long-term memory. The derived score, Imagery (Table IV), gives the time the subject needs to both recall the items and form the images. One way to learn new material is to form images that link it with old known material. The ability measured in Imagery is probably a building block for the image-link process.

Delayed Recall Test

The delayed recall test was then given. The procedure differed slightly between the control and mnemonic groups. For both groups, each Spanish word from the list for the experimental phase was presented and pronounced. The control group subjects were then to give each English meaning. The subjects in the mnemonic group were asked to give both the keyword and the English meaning.

The experiment ended with a short time to debrief each subject. At this point the subject was told that the experiment concerned different ways of learning foreign language vocabulary. The entire session covered approximately fifty minutes.

Experimental Design and Calculations

The split-plot design for assessing the proportion of the lists of English meanings correctly recalled had one between-subjects treatment (control versus mnemonic group) and two within-subjects treatments. One of the within-subjects treatments was the phase of the experiment (baseline or experimental). The other within-subjects treatment was the trial within each phase (trial one or trial two).

Several *t*-tests were used to assess the differences between the groups on (a) various demographic variables and (b) the proportion of the experimental phase list remembered in the delayed recall test.

Six sets of stepwise regression analyses were done. The same three sets of analyses were done with the data from the Control and Mnemonic groups. For each set, the seven variables to be predicted were: performance on each of the trials in the baseline and experimental phases, the total scores for the baseline and experimental phases, and the scores on the delayed recall test. The predictor variables for the first set of analyses were the demographic variables and the basic process task measures. The second set of analyses used only the demographic measures as predictors. The third set of analyses used only the basic process task measures as predictors. The particular variables used in each of these sets of analyses are listed in Appendix D.

Five correlation matrices were created. One involved correlating the demographic variables with the basic process task measures. Next, two matrices correlating the demographic variables with some of the proportion measures for learning the lists were done. One of these involved the control group data while the other utilized the mnemonic group's data. Finally, two other matrices correlating the basic process measures with some of the proportion measures for the list learning were completed. Again, one of these was based on control group data while the other used mnemonic group data. The demographic variables included several groups of WISC-R subscale scores that have appeared as factors in two factor analytic studies (Kaufman, 1975; Smith, Coleman Dokecki & Davis, 1977). The manes and components of these factors are listed in Appendix E. The particular measures correlated in each of the five correlation matrices are listed in Appendix D

CHAPTER III

RESULTS

The data analyzed consisted of both demographic factors (such as age and scores on the WISC-R) and performance scores from the various tasks involved in this study. A comparison of the data for the two groups on the demographic variables will first be made. This is to examine the similarities and differences between the groups. Next, the analysis on the proportion of items recalled by each group on the baseline and experimental phases will be presented. Study time factors for the two phases will also be described at that point to see if they account for the differences in recall performance. The third area to be considered is the performance of the two groups on the delayed recall test. The regression analyses are then discussed. Finally, there will be a description of the patterns of variables, both demographic and performance, that appear to either vary together or be relatively independent of each other.

Demographic Characteristics

A comparison of the control group and the mnemonic group on a number of demographic variables indicates that the groups are quite similar. Table V (Appendix F) presents the means, standard deviations, _t_-scores, and probability levels for the variables that were compared: age, grade, full scale intelligence score in the WISC-R, verbal and performance intelligence scores on the WISC-R, and the grade levels for the subject's performance on the WRAT reading, arithmetic, and spelling tests. There was no significant difference at the .05 level between the means for all but two of these variables. The grade level was significantly different, (t (38) = 2.19, p < .05) with the control group having a mean of 8.3 and the mnemonic group having a mean of 7.45. The groups were also different on the reading test of the WRAT (t (38) = -2.038, p < .05). The control group had a mean grade level on this test of 4.16 while the mnemonic group was 5.17. By examining the performance of the two groups during the baseline phase of the learning of the pairs, it is possible to see if their differences seemed to effect learning rates.

Recall Data

Figure 1 is a graph of the proportion of the list of English meanings recalled correctly by each group on the baseline phase, experimental phase, and the delayed recall test. The proportions for each of the two phases are based on the sum of the items recalled over the two trials. Clearly the groups performed at an equivalent level on the baseline phase. In the experimental phase, the mnemonic group recalled a greater proportion of English meanings in comparison to the control group. As was expected, the control group's performance remained essentially equivalent between the two phases. The large interaction effect produced is due to the increase in the proportion recalled by the mnemonic group in the experimental phase. Table VI (in Appendix F) presents the means and standard deviations of the proportions of the lists known in the baseline phase, experimental phase, and delayed recall test. The analysis of variance on this data indicated that there was a significant group

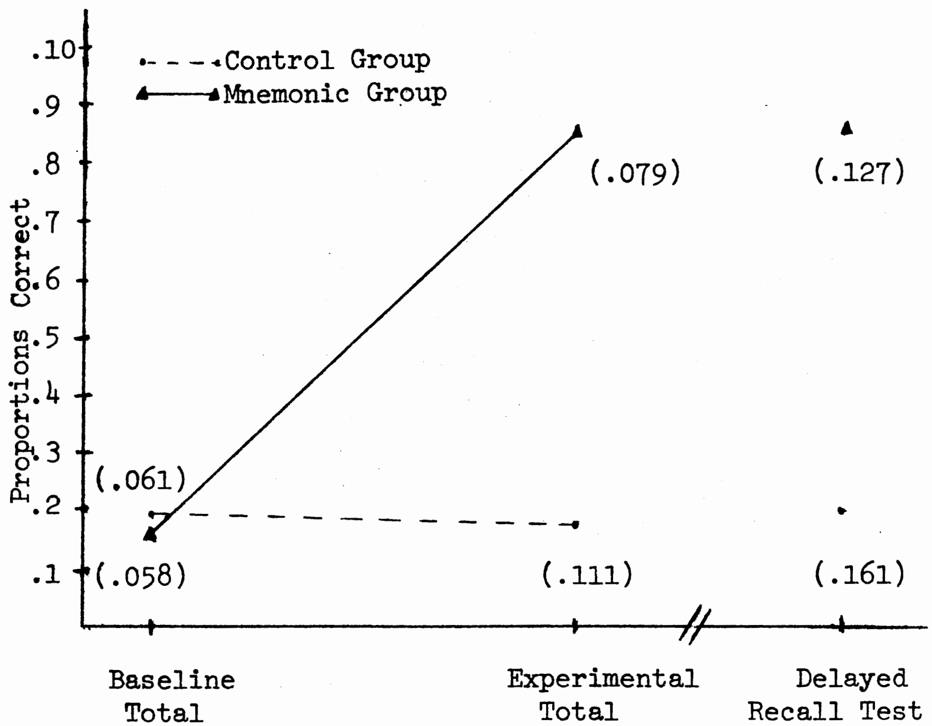

Figure 1. Proportions of Lists Recalled in Various Phases of the Experiment (And Standard Deviations)

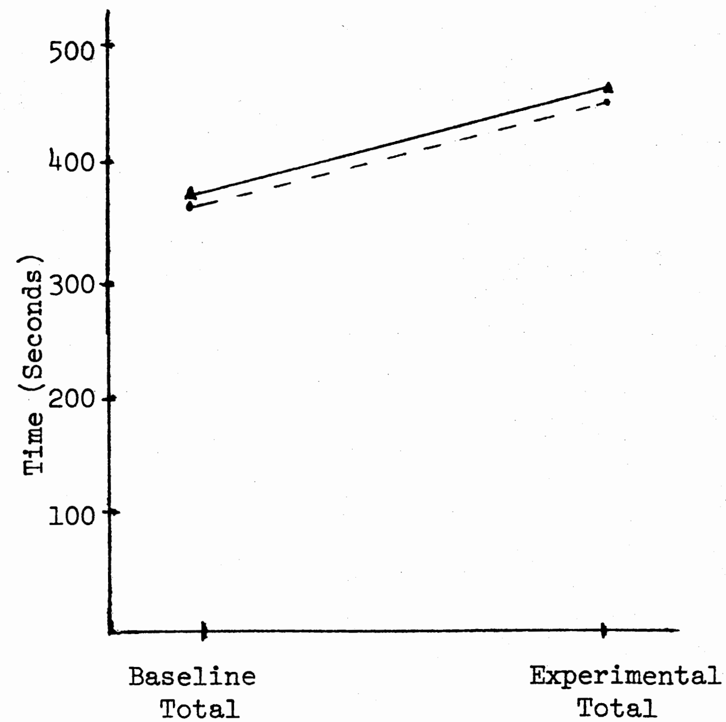

Figure 2. Average Time Spent Studying Lists in Phases of Experiment

effect, (F (1,38) = 251.61, $p < .0001$). There was also a significant phase effect, (F (1,38) = 513.15, $p < .0001$). The group by phase interactions was significant, ($F(1,38)$) = 551.38, $p < .0001$). In addition, there was a significant trials within phases effect, ($F(1,2) = 47.38$, $p < .0001$). Groups by trials within phases was not significant. A complete presentation of the analysis of variance results can be found in Table VII (Appendix F). Both Figure 1 and Table VII clearly show the effectiveness of the keyword method in helping learning disabled boys learn pairs of Spanish words and their English meanings.

A time comparison was required to make sure the results in the experimental phase were not due to differences in the amount of study time used by the groups. Figure 2 presents the average number of seconds the groups spent studying each list. Each subject's study time for the two trials was added and the mean of these was found for each group. On the baseline phase, the mean of the study times was 358.25 seconds (S.D. = 12.88) for the control group and 362.85 seconds (S.D. = 13.44)for the experimental group. For the second phase the mean number of seconds for the control group was 448.80 (S.D. = 26.75) and 453.70 (S.D. = 30.68) for the mnemonic group. A more complete presentation of the results of the analysis of variance for the study times is located in Appendix F. Clearly, the mnemonic and control groups can be considered as equivalent to one another in time spent on each phase.

The data for the delayed condition consisted of the proportion of English meanings correctly recalled from the second list when approximately five minutes of interpolated activities (basic process tasks) followed the study-test trials. For the control group, the mean proportion correct was .192 (S.D. = .160). The mean proportion correct for the mnemonic group was .850 (S.D. = .126). As can be seen from Figure 1, these levels are quite close to the proportion learned on the experimental phase. A *t*-test indicated that the difference between these means was significant at the .0001 level, *t*(38) = -14.3588. This suggests that the differences in the number of English meanings recalled changed very little even after five minutes of interpolated activities.

Regression Analyses

The regression analyses seemed to be of questionable usefulness. In comparing the control group data regression analyses and the mnemonic group data regression analyses quite different factors received the highest weights for predicting the baseline data. This finding (plus the general lack of patterns in the results for the other regression analyses) suggests that the regression weights have doubtful reliability.

Patterns of Correlations

From the correlation analyses several patterns emerge of (a) highly correlated items and (b) items that seem to be relatively independent of each other. These patterns will be described. The correlations and probabilities for the patterns can be found in Table X in Appendix G.

The patterns of basic process measures that correlate highly with various demographic variables will first be described. The three variables that most highly correlate with both the Speak and Mouth measures are: Comprehension (WISC-R), reading grade level (WRAT), and spelling grade level (WRAT). These are negative correlations indicating that the poorer the subjects did on the Speak and Mouth tasks (longer times) the poorer they did on the three demographic variables (lower scores). It is surprising that Speak and Mouth would correlate so highly with more global abilities. This may suggest that speaking rates have a strong relation to rehearsal effectiveness and thereby influence more global abilities.

A pattern is revealed when one examines the high correlations with the Image and Translate time measures and the number of mistakes on the Image, Translate, and Percept tasks. The Image task correlates at least at the $p < .05$ level with a number of verbal measures on the WISC-R: the full scale score, the verbal intelligence score, Arithmetic, Similarities, and Information. This is a positive correlation: subjects who had longer times on the Image task performed at a higher level on the WISC-R scores. Similar to this, subjects who took a longer time on the Change measure (time to translate from printed capital letters to imagined small letter) received high spelling grade level scores on the WRAT. This seemingly odd direction for the correlations can be better understood in the context of a speed-accuracy trade-off; the greater number of mistakes and/or omissions a subject made on the Image task, the poorer he did on a number of verbal demographic variables. These variables include (a) various WISC-R scores: the Verbal IQ score, Information, Arithmetic, the full scale IQ score, Similarities, Comprehension, Digit Span and Vocabulary and (b) several WRAT scores: the spelling grade level and reading grade level. Similar to this is the result that the number of mistakes made by a subject on the Translate task correlated highly and in the appropriate negative direction with the spelling test on the WRAT and the following WISC-R scores: Information, Picture Arrangement, and the full scale IQ score. Mistakes on the Percept task also correlated negatively with the full scale intelligence score.

Clearly it is important to consider both the time and mistake measures when one investigates the results on the Percept, Translate, and Image tasks.

In looking at the performance of the control group on the list measures the few very strong correlations found are with the total proportion of words recalled on the baseline phase. The primary high correlations were with Digit Span (WISC-R) and the Image measure. To interpret these correlations one needs to remember that Digit Span generally taps a person's primary memory capacity and that the Image measure has to be considered in terms of speed-accuracy trade-off, with speed and errors correlated.

For the mnemonic group's performance the baseline total measure correlated highly and negatively with the number of mistakes made on the Translate task. The proportion of words recalled during the experimental phase correlated with several WISC-R performance measures: Picture Completion and the performance intelligence score. This last result suggests that the same abilities may be used in the performance section of the WISC-R and the keyword method. These abilities may center around the use of information in a pictorial form.

Patterns of Relatively Unrelated Variables

A few interesting patterns were found of variables that appear to be statistically independent of each other in the sense of having a very low correlation. First, subjects tendency to make mistakes on the Percept, Translate, and Image tasks seems to be relatively independent of their grade level. Secondly, the mnemonic group's Digit Span scores were quite independent of their total baseline phase performance, total experimental phase performance, recall of the keywords, and recall in the delay condition. Thirdly, Digit Span scores for all the subjects appeared to be relatively independent of their performance on the Speak, Mouth, and Alter basic process tasks. The lack of correlations with Digit Span is particularly interesting since it is the primary subtest on the WISC-R that taps primary memory capacity.

Another interesting pattern was found involving a sum of the WISC-R Arithmetic, Digit Span, and Coding scale scores. In factor analytic work with normal children's scores, Kaufman (1975) has labeled this factor "Freedom from Distractability." In other factor analytic research with a learning disabled population (Smith, Coleman, Dokecki & Davis, 1977), the same factor was found and was considered a sequencing factor. Smith et al. (1977) found that learning disabled children tend to do less well on this factor than on spatial and conceptual factors. This freedom from distractability factor interestingly seems to be quite independent of most of the basic process measures: Speak, Mouth, Alter, Percept, Translate, and Span. This may suggest that paying attention, or being distractible, is a basic process itself and separate from the abilities measured by these tasks. Results such as these and those presented earlier in this section will be interpreted in the following discussion portion.

CHAPTER IV

DISCUSSION AND SUMMARY

Discussion

The two hypotheses of this study were strongly supported. The hypotheses concerned a comparison of the number of pairs of Spanish words and their English meanings that learning disabled boys would know if they studied by their own methods or learned them using a mnemonic technique, the keyword method. The first hypothesis predicted that during the experimental phase the mnemonic group would learn a significantly larger proportion of the list than the control group. The second hypothesis is that a similar difference would be found on the delayed recall test. These results will be examined, interpreted, and evaluated in terms of (a) their implications, (b) how they fit with previous research, and (c) suggestions for further explorations of this area. This will be followed by an examination of the patterns in the exploratory work involving correlations of demographic variables, measures from the list learning phases, and measures on the basic process tasks.

Use of the Keyword Method

Being taught the keyword method certainly seemed to help learning disabled boys learn the types of pairs used in this study. Large differences were found between the proportion of English meanings recalled by the groups in the experimental phase and delayed test. These differences could not be accounted for in terms of demographic differences in the groups or the amount of time they spent studying the pairs. In fact, there seemed to be a ceiling effect for the mnemonic group during the experimental phase. A number of the subjects knew all but one or two of the items on the first trial and all of the items on the second trial. This suggests that the differences found between the proportions of the learned by the groups during the experimental phase may be an underestimate of what the differences could be.

The data from the delayed recall test suggests that most subjects in the mnemonic group remembered either both the keyword and the English meaning or neither of them. Occasionally a subject would recall the keyword but could not remember the English meaning. There were nine instances where this happened. There was one instance where the reverse occurred. That is, the subject remembered the English meaning but not the keyword. These results indicate that there are some instances where the acoustic link is recalled but the image link is not well enough established to be recalled.

The differences between the proportion of words learned by the mnemonic and control groups are even more dramatic than those described by Atkinson (1975), Atkinson and Raugh (1975), Raugh and Atkinson (1975), and Raugh, Schupbach and Atkinson (1977) with college students. This may reflect a lack of any method of memorizing the material, even rote rehearsal, by many of the learning disabled boys in the control group. It would be much more likely for Atkinson and Raugh's control groups of college students to use some methods to memorize the material, as Ott, Butler, Butler & Ball (1973) found their subjects doing.

Further research concerning the use of the keyword method and other mnemonic techniques by learning disabled children certainly seems to be warranted. One aspect of interest would be how effective the method is for these children when they have to form their own keyword or image or both. The effectiveness of different keywords, especially in terms of whether they sound like the first syllable of the Spanish word or not, would be useful to know. Another aspect is how well the material is retained over a longer period of time than was used in this study. It would also be interesting to see if a third direct Spanish to English link would be formed by the children as Atkinson (1975) suggests will happen with continued practice. Furthermore, it would be valuable to see if the keyword method could be taught to a group or class of learning disabled children rather than having to use individualized instruction in the method. Finally, one of the most useful extensions of the work presented here would be to see how effective the keyword method is for learning disabled children when they are learning pairs of items involved in their typical school work or everyday lives. Possible types of pairs might be: (a) new English vocabulary words and their meaning, (b) historical information such as leaders and what war they were involved in, (c) scientific facts such as the organs of the body and their basic function, and (d) individual's names and faces.

Patterns of Correlations

Each of the eight patterns of correlations cited in the results section will now be examined. The strong negative correlation between the Speak and Mouth tasks and the subject's scores on Comprehension, reading grade level and spelling grade level may suggest that either (a) speed in saying or mouthing letters goes along with reading and spelling skills or (b) recall of a well learned chain like the alphabet is associated with reading and spelling skills. These alternatives could be distinguished by comparing the association between (a) saying the alphabet from memory and (b) reading the alphabet outloud (thus eliminating the memory factor) with one's reading and spelling skills.

The results from the Image task seem to involve a speed-accuracy trade-off. Those subjects who took a long time made few mistakes or omissions. The subjects who did the task quickly either skipped items or classified them incorrectly. The nature of the correlations between the number of mistakes made on the Percept task, the Translate task, or the Image task with WISC-R or WRAT scores seems to suggest that more mistakes are made by subjects that are less intelligent or have poorer reading and spelling skills. Many explanations of this are possible. One is that performance on the three basic process tasks is influenced by intellectual level. Another explanation is that subjects who make a lot of mistakes on the basic process tasks also made a lot of mistakes on the WISC-R and WRAT. This could be interpreted as the result of a distractable or impulsive style rather than intellectual ability. However, this interpretation is at odds with the low correlations between the basic process task measures and the WISC-R distractability factor.

The correlations between the control group's performance in the baseline phase with Digit Span and with the Image measure will now be considered. Digit Span seems to basically be a measure of the capacity of one's primary memory and the ability to process items at the beginning of the list into secondary memory. It makes sense that Digit Span would correlate with the subject's ability to learn a list of paired associates. The correlation of the baseline measure and the Image task can be understood in terms of the Image scores in this study reflecting a speed accuracy trade-off. Therefore, the subjects that took longer on the Image task, but made fewer mistakes, recalled more items during the baseline phase. A similar pattern appears for the mnemonic group on the baseline phase, for better baseline recall is highly and negatively correlated with the number of mistakes made on the Translate task. This suggests that those subjects who made a lot of mistakes were poorer at learning the material in the initial list. An impulsive style of behavior may be the factor behind the mistakes and poorer learning.

The correlations of the mnemonic group's experimental phase measures and scores on the performance section of the WISC-R seem to imply that the abilities tapped on the performance part of that intelligence test may go along with one's ability to quickly utilize the keyword method. This may have to do with the subject's skills in utilizing pictorial or imaginal information.

The general lack of a correlation between a subject's tendency to make mistakes and their grade level suggest that learning disabled children are passed on to higher and higher grades even if they make a lot of mistakes.

The relative lack of a correlation between the Digit Span scores of the mnemonic group and the various measures on the list task is interesting. The lack of correlation on the baseline measure is particularly odd since Digit Span correlated highly with the control group's performance on the baseline phase. The lack of correlations with the other list measures could be interpreted as suggesting that the helpfulness of the keyword method is not associated with one's ability on a serial recall task. This could be seen in terms of their being independence between the subject's primary memory storage limitations and their ability to utilize the keyword method.

Next, the relative lack of correlation between the Speak, Mouth, and Alter tasks and Digit Span seems to suggest that one requires recall of a long generally well learned string from secondary memory while Digit Span requires the current use of basically primary memory abilities.

Finally, the lack of correlation between the basic process tasks and the freedom from distractability (sequencing) factor leaves a great deal of room for speculation. Rugel (1974) has suggested that low scores on the freedom from distractability factor may mean different things depending on whether they are based on an auditory sequencing memory deficit or an attentional disability. If a learning disabled child's score is influenced by either of these deficits, one would expect the deficit to also influence their performance on the basic process tasks. It seems like further research on this aspect would be valuable considering the great amount of recent emphasis placed on the difficulties learning disabled children have in using selective attention (Ross, 1976). It would be particularly valuable to correlate the basic process measures and the distractability factor using a subject population that was less homogeneous.

Summary

This study has shown the effectiveness of a mnemonic technique, the keyword method, in helping learning disabled boys learn pairs of Spanish words and their English meanings. Further research concerning the use of the keyword method and other mnemonic methods by learning disabled children is clearly warranted. When the memory deficits of learning disabled children frequently effect many areas of their academic and social lives, effective mnemonic techniques may have strong positive implications for such children. The exploratory work involving correlations between demographic variables, list performance measures and basic process tasks has produced a number of scattered patterns. Further work that considers the intellectual skills and learning styles of learning disabled children and their ability to remember material with or without the keyword method is certainly needed.

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APPENDIXES

APPENDIX A

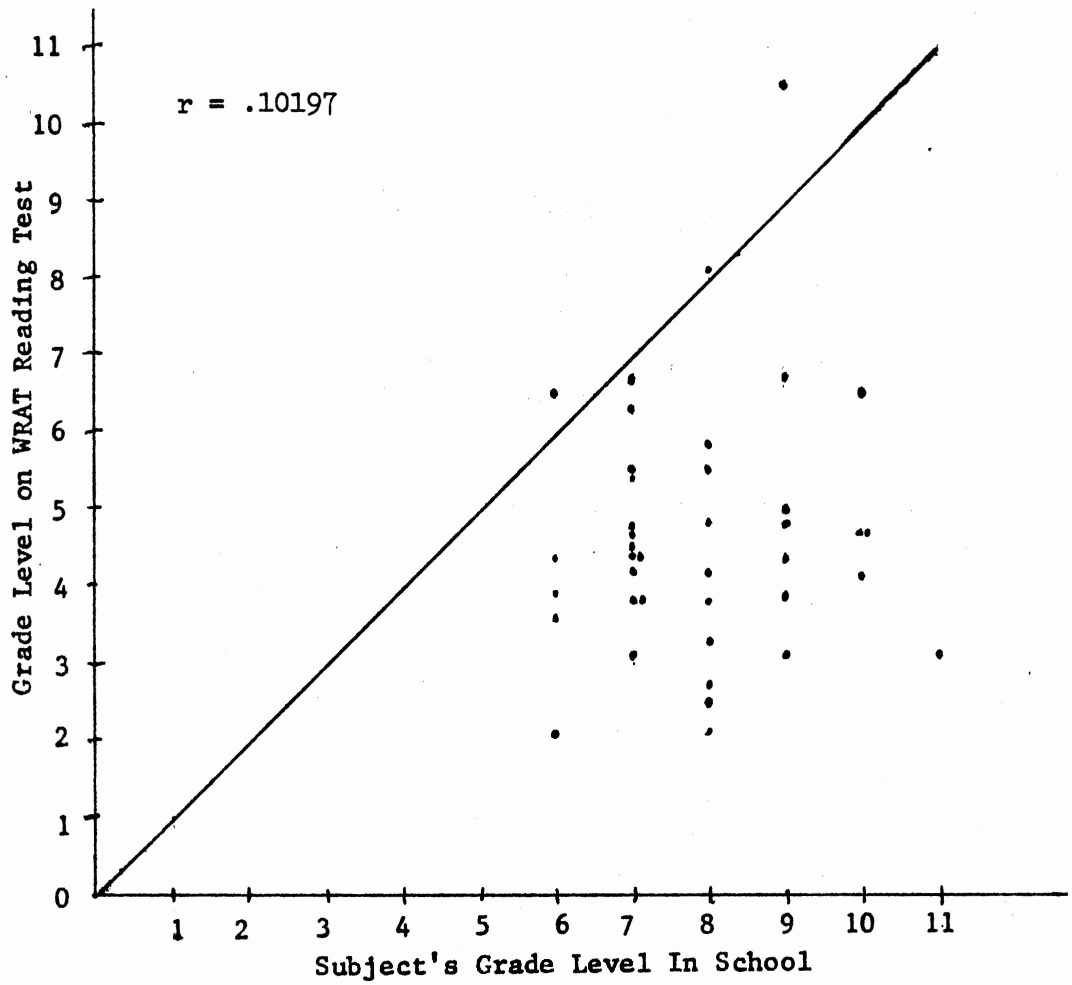

Figure 3. Graph of Subject's WRAT Reading Level With Their School Grade Level

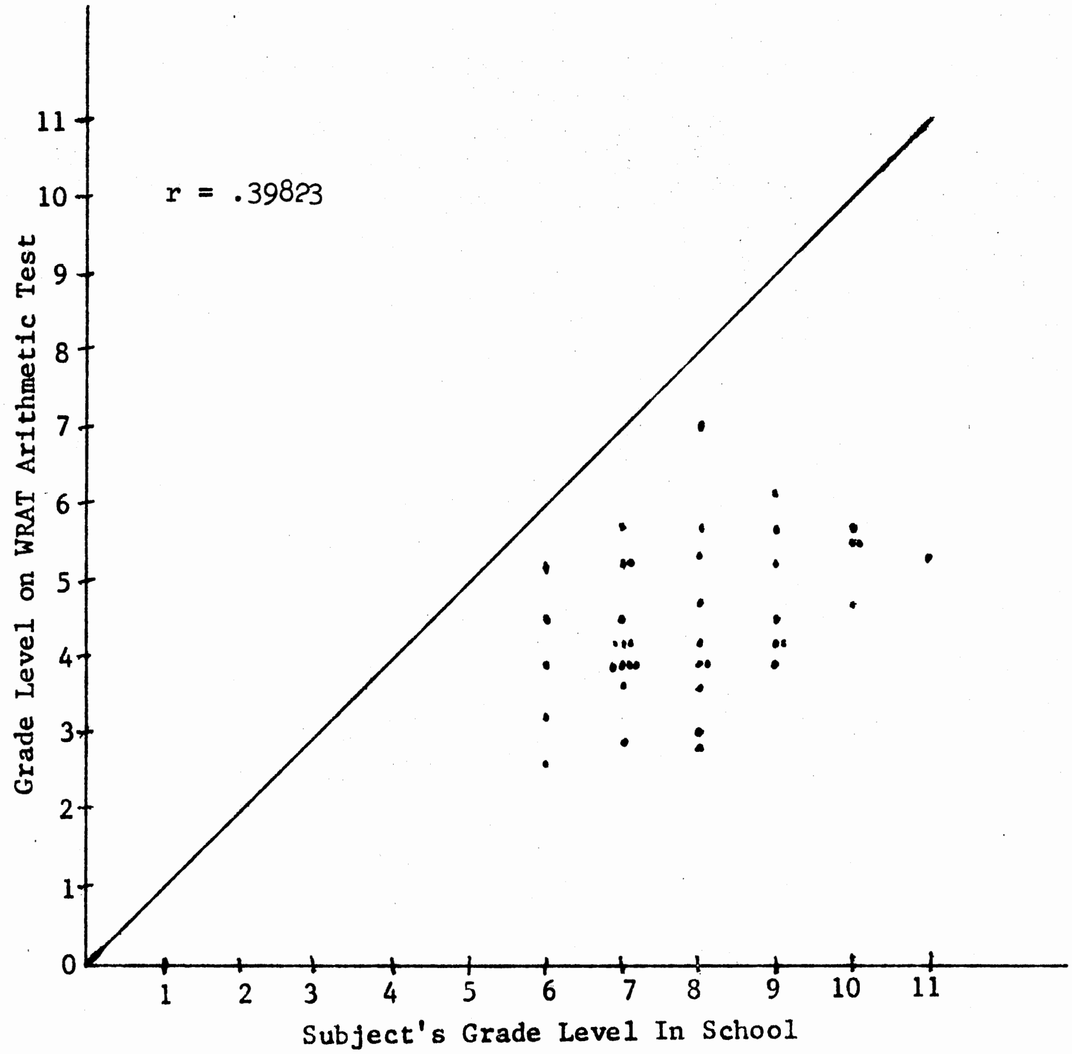

Figure 4. Graph of Subject's WRAT Arithmetic Level With Their School Grade Level

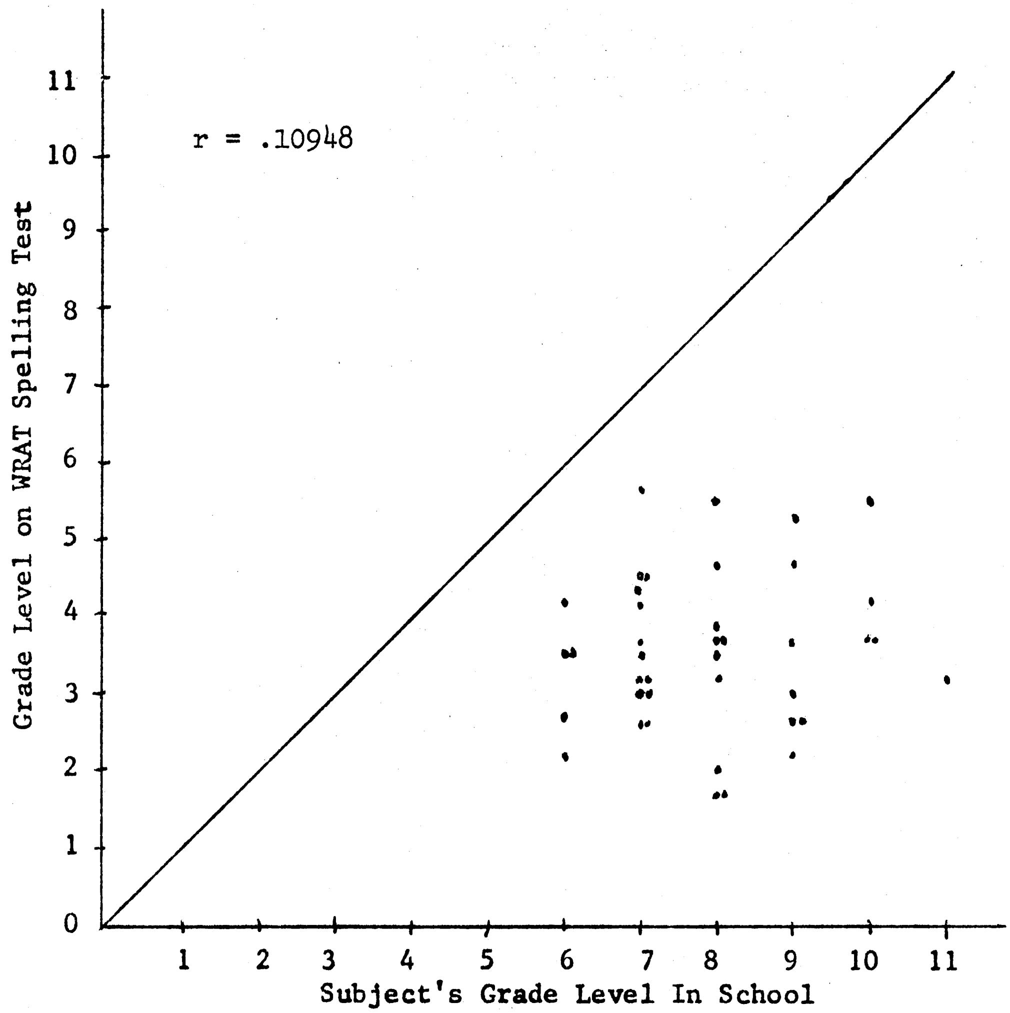

Figure 5. Graph of Subject's WRAT Spelling Level With Their School Grade Level

APPENDIX B

EXAMPLES OF CARDS USED IN STUDY

This appendix presents examples of the cards used in the study. The stimulus words were typed in capitals on eight inch (20.2 cm.) by five inch (12.7 cm.) cards.

JABON

Figure 6. Typical Front Side of Card for Baseline List (Both Groups) and Experimental List for the Control Group

JABON (BONE)

Figure 7. Typical Front Side of Card for the Mnemonic Group in the Experimental Phase

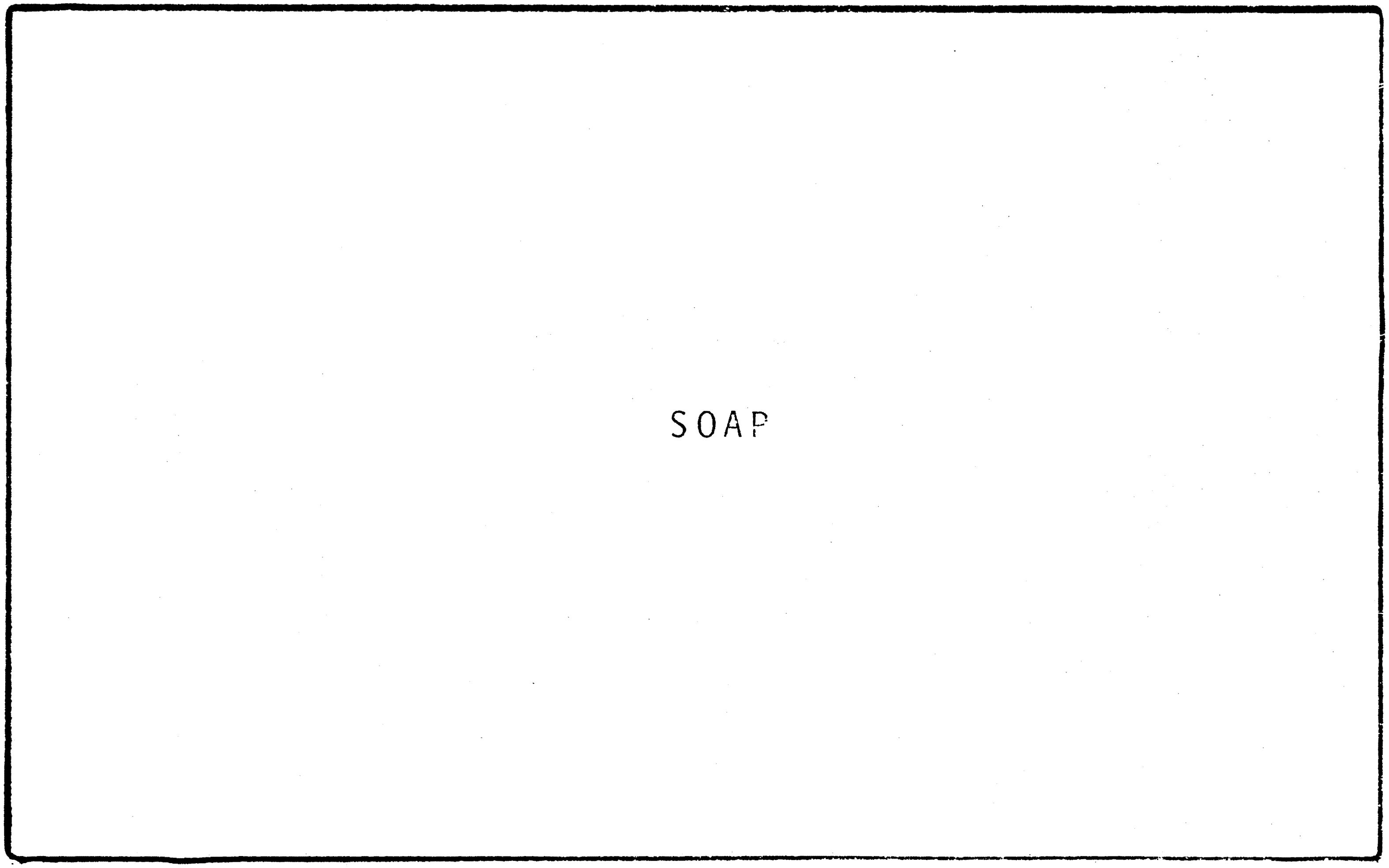

Figure 8. Typical Back Side of Card for Both Groups on Both the Baseline and Experimental Lists

APPENDIX C

INSTRUCTIONS

Baseline Phase (Both Groups)

I am trying to find out the best way for young people your age to learn Spanish words and their meaning in English. I will show you and pronounce each Spanish word. I will both tell and show you the English meaning of each word. Here is a short example list:

Campo, campo is a Spanish word meaning field, field.
Tiempo, tiempo is a Spanish word meaning time, time.
Hogar, hogar is a Spanish word that means home, home.

After I have shown you a series of Spanish words and their meanings, you will be given a recall test. I will present a Spanish word from the list and you will be asked to give the correct English meaning. associated with that Spanish word. For example:

If I say tiempo, then you would say_______. That is right.
And if I say hogar, you would say_________. Right.
And for campo, ______. Fine.

Here is the list that you will be given the recall test over. I will present the words like I did for the example. It is just a longer list. Do you have any questions? (Baseline list, trial 1)

Now I will show you each of those Spanish words and you are to tell me their English meanings. (Baseline list, recall test 1)

Now I will show you these words for you to study again. Then I will give you another recall test. Lets see if you can know more of them this time. (Baseline list, trial 2)

Here is the recall test. (Baseline list, recall test 2)

Teaching Period (Control Group)

Here is a short list on which to practice. I will present the items in the list to you once. For each Spanish word, I will show it to you and pronounce it. Then I will show you its meaning in English. After we have completed the list I will give you a recall test. (Teaching Period List)

Here is the recall test. (Teaching Period List, recall test)

Teaching Period (Mnemonic Group)

In this part, I will teach you a memory aid to help you learn Spanish words and their English meaning. For this memory aid you will use what is called a linking word (like a link in a chain). A linking word is an English word that sounds like part or all of a Spanish word. For example:

For the Spanish word <u>pato</u>, the linking word is "pot."
For the Spanish word <u>caballo</u>, the linking word is "eye."

When you use the memory aid, I will give you a Spanish word, a linking word, and the English meaning of the Spanish word. For example:

The Spanish word is <u>pato</u>. The linking word is "pot." And the English meaning of <u>pato</u> is "duck."
The Spanish word is <u>caballo</u>. The linking word is "eye." And the English meaning of <u>caballo</u> is "horse."

As the aid to remembering, you are to make a picture in your mind of the linking word doing something with the English meaning. Here are some examples:

If the Spanish word is <u>pato</u>, the linking word is "pot," and the English meaning is "duck," you would make a picture in your mind of a duck doing something with a pot. You might make a picture of a duck with a pot worn on his head as a hat. Make that picture in your mind. Do you see it clearly? Describe it to me.

If the Spanish word is <u>caballo</u>, the linking word is "eye," and the English meaning is "horse," you would make a picture in your mind involving a horse and an eye. The picture might be of a horse with one big eye in the middle of his forehead and the eye is winking at you. Make that picture in your mind. Do you see it? Describe it to me.

Make the picture as funny or unusual as possible, then it will be easier to remember. When you see the Spanish word, the linking word and the picture will help you remember the English meaning.

Do you understand the memory aid? Do you have any questions about it? Here are three Spanish words on which to practice this memory aid. (Last three items of Teaching Period List)

Let us see how many of these you know. (Teaching Period List, recall test)

Experimental Period (Control Group)

Now I will show you another series of Spanish words and their English meanings. You are to learn these as we go through the list. After you have studied all of the words, I will give you another recall test. For that test I will show you the Spanish words. You are to tell me their English meanings. (Experimental List, trial 1)

Here is the recall test. (Experimental List, recall test 1)

Now I will show you the words for you to study again. Then I will see how many you know. Lets see if you can know more of them this time. (Experimental List, trial 2)

Here is the second recall test. Lets see how many you know now. (Experimental List, recall test 2)

Experimental Period (Mnemonic Group)

Now I will show you a series of Spanish words, their linking words, and their English meanings. Learn these using the memory aid. I will tell you a picture to make in your mind. Nod your head "yes" when you see the picture clearly. After I have shown you all the words, I will give you a recall test. For this test, I will show you the Spanish word and the linking word. You are to tell me the meaning of the Spanish word. (Experimental List, trial 1)

Here is the recall test. Think of the linking word. That will tell you the picture and the picture will tell you the English meaning. (Experimental List, recall test 1)

Next, I will show you the words for you to study again. In studying them, think of the linking word and what was in the picture with the linking word. See the picture clearly again. If you can not remember the picture, tell me so. I will then remind you of the picture. Let us see if you can know more of them this time. (Experimental List, trial 2)

Here is the second recall test. Lets see how many you know now. (Experimental List, recall test 2)

Basic Process Tasks (Both Groups)

Here are some different things to do. They use the alphabet. First, say the alphabet for me. (The subject says the alphabet.) Fine. (If the subject does not know the alphabet well, the experimenter and the subject say it together several times.)

Now, when I tell you to begin, you are to say the alphabet as quickly as you can. When you come to the end of it say "stop." So I will say "begin" and you will say "a, b, c. . . x, y, z, stop." Do you have any questions? Say them as quickly as you can.

Next, I want you to mouth the alphabet as quickly as you can. So after I say "begin," I want you to go through the alphabet like this "(a), (b), (c) . . . (x), (y), (z), stop." Be sure to say "stop" when you get to the end. Do you understand? Mouth the alphabet as quickly as you can.

Now, I want you to alternate between saying and mouthing the alphabet. So after I say "begin," I want you to go through the alphabet like this "a, (b), c, (d), e, (f) . . . (x), y, (z), stop." Do you understand? Do you have any questions? Go through the alphabet like that once for practice. (The subject practices the task.) Now, go through it as quickly as you can. If you make a mistake, keep going.

This time I want you to read through the alphabet saying if letters are either tall or not tall. This is half a typed space. Letters which are larger than half a typed space are tall. So <u>b</u> is tall because of this part. <u>T</u> is tall because of this part. <u>Y</u> is tall because of its tail. Letters like <u>a</u> and <u>z</u> are not tall because they fit in half a typed space. For each tall letter you are to say "yes" and for each letter that is not tall you are to say "no." So with <u>b</u> you would say "yes." With <u>t</u>, "yes." With <u>y</u>, "yes." With <u>a</u>, "no." With <u>z</u>, "no." As an example, I will start from the end of the alphabet, "no, yes, no . . . ." Do you understand? You are to start from the begining of the alphabet and go as fast as you can.

Now I have a card with all the letters in capitals. You are to do the same thing, saying "yes" for tall letters and "no" for letters that are not tall. You will have to look at the capital letters and think if their small letters are tall or not. Do you understand? Remember to go as quickly as possible.

This time I want you to do the same thing, only I will not show you a card. You will have to picture in your mind what the letters look like. Do you have any questions?

Now, I will read a list of letters. When I am through reading all of them you are to write down an many as you remember in any order. Do you understand? Do not write down any until I have read all of them. (The following letters are read at a rate of one every two seconds.) "C, H, L, M, R, J, X, G, Q, K, S, V."

Delayed Recall Test (Control Group)

Now I will give you one more recall test over the last list of Spanish words that you studied. I will show you and pronounce each Spanish word and you are to tell me the meaning of the Spanish word. (Experimental List, delayed recall test)

Delayed Recall Test (Mnemonic Group)

Now I will give you one more recall test over the last list of Spanish words that you studied. I will show you and pronounce each Spanish word and you are to tell me both the linking word and the meaning of the Spanish word. (Experimental List, delayed recall test)

APPENDIX D

REGRESSION ANALYSES

Variables Predicted In Each Set Of Analyses: Baseline List, trial 1
Baseline List, trial 2
Baseline Total
Experimental List, trial 1
Experimental List, trial 2
Experimental Total
Delayed Recall

Two Sets Of Regression Analyses (One with Control Group Data and the other with Mnemonic Group Data) Were Done With Each of the Following Groups of Predictor Varables:

(a) Demographic Variables and Basic Process Measures: age, grade, Full Scale IQ score, Verbal IQ score, Performance IQ score, Reading Grade Level (WRAT), Arithmetic Grade Level (WRAT), Spelling Grade Level (WRAT), Speak, Mouth, Alter, Percept, Translate, Image, Span, Percept Mistakes, Translate Mistakes, Image Mistakes, Switch, Change, Imagery, Perceptual Organization, Verbal Comprehension, Freedom From Distractibility

(b) Demographic Variables: age, grade, Full Scale IQ score, Verbal IQ score, Performance IQ score, Reading Grade Level (WRAT), Arithmetic Grade Level (WRAT), Spelling Grade Level (WRAT)

(c) Basic Process Measures: Speak, Mouth, Alter, Percept, Translate, Image, Span, Percept Mistakes, Translate Mistakes, Image Mistakes, Switch, Change, Imagery

CORRELATION MATRICES

(a) Demographic Variables with the Basic Process Task Measures

Demographic Variables: age, grade, Full Scale IQ score, Verbal IQ score, Performance IQ score, Information, Similarities, Arithmetic, Vocabulary, Comprehension, Digit Span, Picture Completion, Picture Arrangement, Block Design, Object Assembly, Coding, Verbal Comprehension, Perceptual Organization, Freedom From Distractibility, Conceptual, Spatial, Acquired Knowledge, Reading Grade Level (WRAT), Arithmetic Grade Level (WRAT), Spelling Grade Level (WRAT)

Basic Process Task Measures: Speak, Mouth, Alter, Percept, Translate, Image, Span, Percept Mistakes, Translate Mistakes, Image Mistakes, Switch, Change, Imagery

(b) Demographic Variables with List Learning Measures (Seperate matrices of this kind were done for the control group data and the mnemonic group data.)

Demographic Variables: age, grade, Full Scale IQ score, Verbal IQ score, Performance IQ score, Information, Similarities, Arithmetic, Vocabulary, Comprehension, Digit Span, Picture Completion, Picture Arrangement, Block Design, Object Assembly, Coding, Verbal Comprehension, Perceptual Organization, Freedom From Distractibility, Conceptual, Spatial, Acquired Knowledge, Reading Grade Level (WRAT), Aritmetic Grade Level (WRAT), Spelling Grade Level (WRAT)

List Learning Measures (proportion correct): baseline total, experimental phase total, delayed recall test

(c) Basic Process Measures with List Learning Measures (Seperate matrices of this kind were done for the control group data and the mnemonic group data.)

Basic Process Measures: Speak, Mouth, Alter, Percept, Translate, Image, Span, Percept Mistakes, Translate Mistakes, Image Mistakes, Switch, Change, Imagery

List Learning Measures (proportion correct): baseline total, experimental phase total, delayed recall test

APPENDIX E

FACTORS FOUND IN FACTOR ANALYTIC RESEARCH WITH THE WISC-R

Kaufman's (1975) Factors (from research with a normal population of children):

Verbal Comprehension: Information, Similarities, Comprehension, Vocabulary

Perceptual Organization: Picture Completion, Picture Arrangement, Block Design, Object Assembly

Freedom From Distractibility: Arithmetic, Digit Span, Coding

Smith, Coleman, Kokecki, and Davis' (1977) Factors (from research with a population of learning disabled children):

Conceptual: Similarities, Comprehension, Vocabulary

Spatial: Picture Completion, Block Design, Object Assembly

Sequential: Arithmetic, Digit Span, Coding

Acquired Knowledge: Information, Arithmetic, Vocabulary

APPENDIX F

DATA ANALYSES

This appendix includes tables presenting the results of various statistical analyses that were done on the demographic data, list learning scores, and basic process task measurements.

TABLE V

A COMPARISON OF THE GROUPS ON THE DEMOGRAPHIC VARIABLES

Variable	Total Sample		Control Group		Mnemonic Group		Control versus Mnemonic	Control versus Mnemonic
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	t	p
Age	13.73	(1.38)	13.95	(1.28)	13.50	(1.47)	1.0342	0.3077
Grade	7.88	(1.28)	8.30	(1.45)	7.45	(0.94)	2.1918	0.0356
Full Scale IQ	93.20	(6.42)	93.65	(6.19)	92.75	(6.77)	0.4386	0.6635
Verbal IQ	89.13	(8.22)	89.45	(8.09)	88.80	(8.55)	0.2470	0.8063
Performance IQ	99.98	(8.06)	100.30	(7.87)	99.65	(8.44)	0.2520	0.8024
Reading Grade Level	4.66	(1.63)	4.16	(1.11)	5.17	(1.92)	-2.0380	0.4860
Arithmetic Grade Level	4.51	(0.95)	4.45	(0.89)	4.57	(1.03)	-0.3790	0.2068
Spelling Grade Level	3.56	(1.02)	3.38	(0.88)	3.73	(1.14)	-1.0918	0.2818

TABLE VI

PROPORTIONS OF WORDS RECALLED

Phase Of Experiment	Control Group		Mnemonic Group	
	Mean	Standard Deviation	Mean	Standard Deviation
Baseline Phase				
Baseline Trial 1	.129	(.085)	.107	(.054)
Baseline Trial 2	.229	(.092)	.196	(.089)
Baseline Total	.179	(.061)	.152	(.058)
Experimental Phase				
Experimental Trial 1	.107	(.082)	.743	(.121)
Experimental Trial 2	.225	(.172)	.954	(.071)
Experimental Total	.164	(.111)	.848	(.079)
Delayed Recall Phase				
Keyword	----	----	.879	(.109)
Delayed Recall Test	.193	(.161)	.850	(.127)

TABLE VII

ANALYSIS OF VARIANCE FOR THE PROPORTIONS OF ENGLISH MEANINGS RECALLED

Source	df	SS	F	p
Between Subjects				
Groups	1	4.295	251.61	.0001
Within Subjects				
Phase	1	4.678	513.18	.0001
Group X Phase	1	5.026	551.38	.0001
Trial Within Phase	2	0.719	47.38	.0001
Group By Trial Within Phase	2	0.044	2.88	N.S.

TABLE VIII

ANALYSIS OF VARIANCE FOR THE TIME SPENT
IN THE STUDY ASPECT OF THE TRIALS

Source	df	SS	*F*	*p*
Between Subjects				
Group	1	225.625	0.92	N.S.
Within Subjects				
Phase	1	82264.900	321.40	.0001
Groups By Phase	1	0.225	0.00	N.S.
Trials Within Phase	2	140849.000	289.59	.0001
Groups By Trials Within Phase	2	37.850	0.08	N.S.

TABLE IX

MEANS AND STANDARD DEVIATIONS ON THE BASIC PROCESS TASKS

Measurement	Total Sample		Control Group		Mnemonic Group	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Speak	6.55	(3.32)	6.65	(3.84)	6.45	(2.80)
Mouth	6.18	(3.33)	5.90	(3.09)	6.45	(3.61)
Alter	27.55	(8.15)	27.65	(7.74)	27.45	(8.74)
Percept	20.73	(4.71)	20.45	(3.93)	21.00	(5.47)
Translate	34.00	(13.23)	32.50	(9.99)	35.50	(15.95)
Image	48.00	(21.28)	44.40	(17.39)	51.60	(24.49)
Span	6.13	(1.60)	5.80	(1.54)	6.45	(1.64)
Percept Mistakes	1.00	(1.78)	1.45	(2.33)	0.55	(0.83)
Translate Mistakes	1.98	(1.51)	2.10	(1.59)	1.85	(1.46)
Image Mistakes	4.18	(2.88)	4.25	(3.02)	4.10	(2.81)
Switch	21.19	(7.57)	21.38	(8.05)	21.00	(7.26)
Change	13.28	(13.52)	12.05	(11.07)	14.50	(15.80)
Imagery	27.28	(20.82)	23.95	(16.14)	30.60	(24.61)

APPENDIX G

TABLE X

PATTERNS OF HIGHLY CORRELATED OR INDEPENDENT VARIABLES

Main Item	Correlations of Other Variables With Main Item			
Speak	Comprehension	Reading	Spelling	
r	-0.47436	-0.36512	-0.34357	
p	0.0020	0.0205	0.0300	
Mouth	Comprehension	Reading	Spelling	
r	-0.43746	-0.34364	-0.30168	
p	0.0046	0.0299	0.0585	
Image	Full Scale IQ	Verbal IQ	Arithmetic	Similarities
	0.41556	0.38175	0.35393	0.32129
	0.0076	0.0151	0.0251	0.0432
	Information			
	0.30714			
	0.0539			
Trans	Spelling			
	0.41339			
	0.0080			
Image Mistakes	Verbal IQ	Information	Full Scale IQ	Similarities
	-0.48775	-0.46731	-0.38163	-0.36927
	0.0014	0.0024	0.0151	0.0190
	Comprehension	Digit Span	Vocabulary	Spelling
	-0.35975	-0.33977	-0.32663	-0.49637
	0.0226	0.0397	0.0397	0.0011
	Arithmetic	Reading		
	-0.45995	-0.34276		
	0.0028	0.0304		

TABLE X (CONTINUED)

Translate Mistakes	Information -0.40580 0.0094	Picture Arrangement -0.33384 0.0353	Full Scale IQ -0.31404 0.0484	
Percept Mistakes	Full Scale IQ -0.32021 0.0440			
Baseline Total (Proportion Correct) For Control Group	Digit Span 0.59539 0.0056	Image 0.63459 0.0027		
Baseline Total (Proportion Correct) For Mnemonic Group	Translate Mistakes -0.58444 0.0068			
Exprimental Total (Proportion Correct) For Mnemonic Group	Picture Completion 0.00147 0.0050	Performance IQ Score 0.51742 0.0195		
Grade	Percept Mistakes 0.00000 1.0000	Translate Mistakes 0.17012 0.2940	Image Mistakes 0.08225 0.6139	
Digit Span For Mnemonic Group	Baseline Total -0.07047 0.7678	Experimental Total 0.06160 0.7964	Keyword 0.03289 0.8905	Delayed Recall Test -0.00514 0.9828
Digit Span For All Subjects	Speak -0.03146 0.8472	Mouth -0.02375 0.8844	Alter 0.0850 0.6215	
Freedom From Distractability	Speak 0.06085 0.7092	Mouth 0.05319 0.7444	Alter 0.06452 0.6925	Percept -0.08591 0.5981
	Translate 0.11935 0.4632	Span 0.06517 0.6895		